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TABLE OF CONTENTS.

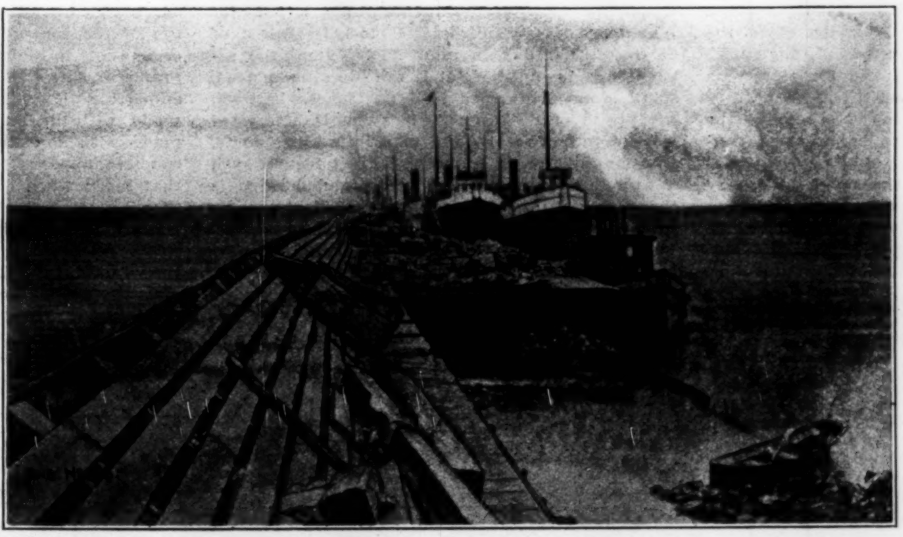
LEADING ARTICLES: Page
The Concrete Breakwater at Harbor Beach, Mich. (illustrated); Emile Low, M. Am. Soc. C. E. 339
Licensing Surveyors and Engineers Connected with the Utilization of Water in Wyoming 341
Some New Facts Relating to the Effect of Meters on the Consumption of Water (illustrated); William S. Johnson, M. Am. Soc. C. E. 342
A Masonry Arch Bridge at Orleans, France (illustrated) 345
A Chicago Warehouse of Reinforced Concrete Construction (illustrated) 346
Decision in the Cameron Septic Tank Suit against Saratoga Springs, N. Y. (illustrated) 347
A Reinforced Concrete Form for Concrete Conduits (illustrated); W. L. Butcher, Assoc. M. Am. Soc. C. E. 352
Annual Convention of the American Railway Engineering and Maintenance-of-Way Association 352
The Latest Panama Canal Commission Appointee: Rear Admiral H. H. Rousseau (illustrated) 354
The Relation Between Seasonal Temperature and Typhoid Fever at Youngstown, O. (illustrated) 354
Concrete Tile Roofing for Mills and Industrial Buildings (illustrated) 358
The New Intake Tunnel and Accessories for the Water-Works of Buffalo, N. Y. (illustrated) 359
Committee Reports on the American Railway Engineering and Maintenance of Way Association 359
Rating Current Meters Through the Ice (illustrated); C. Robert Adams 362
Notes from the Engineering Schools 362
EDITORIAL 355
Valuable Water Meter Data—The Septic Tank Patent Infringement Decision—A Comprehensive Study of the Natural Water Resources of the United States—The Cost of Maintenance of Highways—Water Pollution Nonsense—An Authoritative Word on the Cost of "Electrification."
Switch-Closing Devices and Switch Protection on Main Tracks 356
LETTERS TO THE EDITOR 357
Cracks in U-Abutments; Joseph Wright—Natural Cements; W. J. H. Payne—Engineer's Estimates for Partial Payments; Ray S. Blinn—A Device for Long-Distance Tape Reading (illustrated); Jno. H. Ferguson—A Method of Scaling Earthwork Quantities from a Profile (illustrated); F. Lavis—A Detachable Concrete Column Form (illustrated); Waldo S. Coulter—Tables for Roadmasters (illustrated); W. W. Gaffin—Notes and Queries.
ENGINEERING NEWS OF THE WEEK 362
PERSONALS 363
ENGINEERING SOCIETIES 364

THE CONCRETE BREAKWATER AT HARBOR BEACH, MICH.

By EMILE LOW,* M. Am. Soc. C. E.

In Engineering News of May 29, 1902, there was described in minute detail the concrete superstructure to the breakwater at Buffalo, N. Y. There is now being erected at Harbor Beach, Mich., a new superstructure on the foundations of the old breakwater there which is in some ways similar to the Buffalo structure. The Michigan structure is the subject of this article, the principal features of which have been compiled from reports of the Chief of Engineers, U. S. A.

DESCRIPTION OF THE HARBOR.—The site for this harbor, selected in 1872 after careful consideration, is on the west shore of Lake Huron. It furnishes the only harbor of refuge for vessels in storms between the north side of Saginaw Bay and the foot of Lake Huron at the city of Port Huron. The shore line throughout this portion of the lake being entirely unbroken, the harbor had to be constructed by building into the lake, and was formed by three breakwaters or piers, as they are sometimes called, in the position shown on the accompanying map, Fig. 1. These piers have been ordinarily designated as the "north pier," "main pier" and "south pier." The shore at Harbor Beach is composed partly of shelving rock, somewhat shaly in character, and at other places of clay and hardpan overlying the bed rock. The bottom inside the harbor has, since its construction, accumulated a few feet of soft mud, especially in the central and western portions. The bottom nowhere affords good anchorage.



OLD TIMBER SUPERSTRUCTURE TO HARBOR BEACH BREAKWATER.

CONSTRUCTION OF TIMBER BREAKWATER.—The work of construction was commenced in 1873 under a project providing for three sections of breakwater (as mentioned above) made of stone-filled cribs, so located as to shelter a water area of some 650 acres, and for deepening this area by dredging where necessary. The sheltering breakwaters, with a total length of 8,177 ft., were completed in 1885, at a cost of about $975,000.

The main pier is 4,716 ft. long, which includes two short angles at the north and south ends respectively. It has a width of 38 ft. and stands in water having a depth ranging from 20 to 27 ft. The north pier has a length of 1,505 ft., of which the east section, 1,034 ft. long, is 26 ft. wide, and the west section, 471 ft. long, is 19 ft. wide. The south pier is 1,956 ft. long, of which 218 ft. is 26 ft. wide, 1,032 ft. is 22 ft. wide and 706 ft. is 18 ft. wide.

Since 1885 the expenditures have been applied to keeping these piers in repair, dredging, regulating and controlling the berthing of vessels entering the harbor for refuge, engineering supervision and general office expenses. It has been apparent for a number of years that to render the harbor adequate for the number and character of vessels seeking it for refuge, the timber superstructure of the piers should be replaced with imperishable material and the harbor area increased by dredging.

CONCRETE SUPERSTRUCTURE.—The river and harbor act of March 3, 1899, provided for commencing the work of rebuilding the superstructure of the main pier in concrete and authorized the work to be inaugurated under the continuing-contract system to the extent of $200,000. It was not, however, until 1903 that a definite project for doing the work was decided upon.

Bids for doing the work were received July 18, 1903, and the work awarded to the lowest bidders, Hugo & Tims, of Duluth, Minn. Owing to the lateness of the season and its stormy nature, the contractors were unable to begin operations in the fall of 1903, and on account of the ice the following spring were not able to get their barges out of Lake Superior until June 11, 1904, and owing to the inclement season but little work was accomplished that year.

On Aug. 22, 1905, a second contract for the reconstruction of the superstructure was entered into with the lowest bidders under formal plans and specifications covering the work to be done, the money consideration of the contract being again $200,000. Due to various circumstances not material to a full understanding of the work, this contract was annulled in April, 1906, and relet at the same unit prices to Hugo & Tims, who at that time had already been at work for two years upon the first contract. During the working season of the calendar year 1906, operations were accordingly in progress under this second contract also.

The unit prices for these two contracts were as follows:

	First contract.	Second contract.
Removing old superstructure and levelling cribs, per lin. ft.	$13.00	$8.50
New timber, per M. ft. B. M.	50.00	35.00
Old timber, per M. ft. B. M.	25.00	10.00
Iron bolts and spikes, per lb.	.04	.03
Concrete blocks, per cu. yd.	10.00	10.20
Concrete in place, per cu. yd.	9.00	8.50
Mooring posts, each	45.00	50.00
Oak fenders, per M. ft. B. M.	50.00	50.00
Tie rods, each	15.00	7.00
Rail dowels and eye-bolts, per 25 ft. of completed section	12.50	.....
Rail dowels, per lb.	.....	.02
Burlap	.16	.16

Before going into details as to the methods of construction it may be well to give a short description of the character and design of the adopted form of the superstructure, which was designed by Major Lansing H. Beach, Corps of Engineers, U. S. Army.

The original breakwater was entirely a timber structure built of a cribwork filled with stone topped with a framework as shown in the accompanying illustration. The main pier is 38 ft. wide, and consists of cribs 65 ft. long covered with a continuous superstructure which extends to the average elevation of +8 above ordinary lake level, except on the lake face, where there is built a sea wall whose cross section in the vertical plane is a right-angled triangle. This sea wall rises about 6 ft. above the deck of the superstructure proper. The lake face of the pier is sheeted with 12 × 12-in. vertical timbers 12 ft. long, extending down from the top of the sea wall. This sheeting is drift bolted to the pier and near the water line it is covered with iron plates 4 × 8 ft. by ⅜-in.

The design for the concrete superstructure calls for the removal of this entire old timber superstructure and the top of the timber to an elevation of 2 ft. below ordinary lake level or to Elev. 578. The foundation proper of the new superstructure is formed by the proper preparation and leveling of the top timbers, which includes the two outside walls and the two interior bulkheads, and the placing of a number of additional longitudinal timbers.

This foundation consists essentially of two parts, the semi-submerged concrete blocks and the mass concrete or monolithic blocks. There are four kinds of the former, No. 1 being the harbor face and interior wall blocks with their axes placed parallel with the length of the pier; Nos. 2 and 3, the cross wall blocks; and No. 4 the lake face blocks, with their axes at right angles to the length of the breakwater. The dimensions of these blocks are as follows; Nos. 1 and 4, 4.5 × 10 × 4 ft.; No. 2, 4.0 × 7.5 × 4.0 ft.; No. 3, 4.0 × 7.5 × 11.5 ft. All the blocks have sunken panels in the top face, and in addition blocks No. 1 have joggle channels in the end faces, and blocks No. 4 have these in the side faces.

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*Rome, N. Y.

The blocks when placed as shown by Fig. 3 and the rounded stone filling between, form the foundation for the mass concrete or monolithic blocks.

It will be noted that the cross-section of the concrete superstructure differs radically from the Buffalo, N. Y., design.

DETAILS OF CONSTRUCTION.—In removing the superstructure all the timbers are torn out to a depth of 3 ft. below the summer lake level, 125,000 ft. B. M. of timber being removed from every 100 lin. ft. of pier. The timber above water is mainly hemlock, which of late years it has been necessary to use for repairs, and this is badly rotted, so that it is easily removed. From about 1 ft. above average lake level the timber is, however, perfectly sound, there being many places where the timbers still show the pencil lines made during the framing of the original cribs. Such sound timber as is available is again used in leveling up.

The drift bolts of the original cribs are rather irregular in their spacing and in some places are unusually close together, so that an exceptionally powerful derrick is needed for tearing up. That which is in use is a steel derrick placed upon a heavy scow, with a lifting capacity of about 20 tons.

In addition to removing the timber superstructure, it is necessary to remove 2,100 cu. yds. of stone for every 100 ft. of pier, so as to permit the leveling of the crib-walls at the proper grade. This stone is utilized for making crushed rock, for refilling the cribs after the walls have been properly leveled off, for filling between the concrete blocks, and for riprap on the lake side of the breakwater.

An orange-peel bucket is used to remove the stone, and when the stone to be removed consists largely or exclusively of boulders rapid progress is made. Where the stone is quarry stone with angular edges the orange-peel makes much less progress. As a general rule the stone is removed from the pockets on the harbor side and the pockets on the lake side are not torn out until they have served their purpose as a breakwater for the inside work.

On page 339 is shown a view of the old breakwater with part of the harbor side removed. The walls are leveled to grade by drift-bolting timber of the requisite dimensions to them. Each timber used must be separately fitted in place, so that the work is tedious and requires great care. The cribs are rarely level. They usually have a slope from one end to the other, and at the same time most of the cribs lean toward the harbor side. To place the timber, the men must work in water which is usually 3 ft. deep. As this depth is too little for the employment of divers, the work is performed by men in special wading boots which reach up to their shoulders. Under the most favorable conditions a gang of 7 men can put down from 3,000 to 4,000 ft. B.M. of of timber per day in releveling. When the retimbering is finished and the decking placed, small stone is dumped into the spaces between the pieces of decking. This stone is afterward worked into place by the men in wading boots, who manipulate the stone with their feet in such a way that each piece of timber and decking is thoroughly supported by stone. Crushed rock is then placed over the stone and worked down level with the decking. The cribs are then ready for the concrete footing blocks.

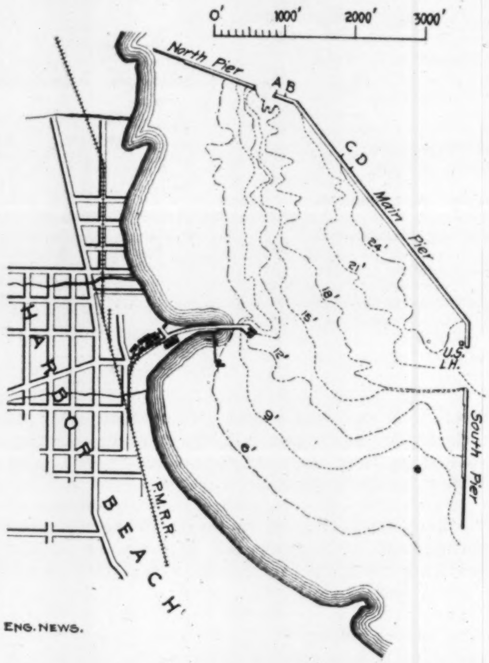

Fig. 1. Map Showing General Location of Breakwater at Harbor Beach, Mich.

CONCRETE BLOCKS.—When operations were started under this contract the concrete for the footing blocks was made of crushed rock and fine sand. The first blocks required 2¾ hours to build. Since then the laborers have become so much more expert that at the present time the largest footing blocks can be made in a little over one hour. The first blocks were made using crushed stone as an aggregate, the proportions being: 1 part cement, 3 parts sand and 6 parts rock, the latter containing on an average 44% of voids, so that the sand was slightly in excess. The concrete was made medium wet and first thoroughly rammed round the sides of the molds with face rammers. The whole surface of each layer was then gone over with cast-iron rammers having a surface 6 ins. square and weighing 30 lbs. Concrete blocks made in this way appeared to be dense, but observation showed that they absorbed considerable water, and when placed in the lake numerous air bubbles appeared on the surface of the block.

During the season of 1904, 2,752 bbls. of cement, 1,146 cu. yds. of sand, 2,293 cu. yds. crushed rock were used in making 2,538 cu. yds. of footing blocks, so that the total quantity of sand and stone was 35.5% in excess of the resulting number of cu. yds. of concrete blocks. Each cu. yd. of concrete contained 1.08 bbls. of cement.

During the year 1905 sand and gravel procured from the St. Clair River near Port Huron were used to some extent in the manufacture of concrete. The so-called gravel is a mixture of both sand and gravel, and is well graded from fine sand to pebbles measuring over 2 ins. From 32 to 38% of the gravel will pass through the meshes of a No. 4 screen, this material being a fine quantity of sand.

In 1905, 2,230 bbls. of cement and 2,728 cu. yds. of aggregate were used to make 2,163 cu. yds. of concrete blocks, the aggregate consisting of 36% sand, 26% crushed rock, and 38% gravel. The aggregate was therefore 26% in excess of the volume of resulting concrete blocks, and 1.031 bbls. of cement were used per cu. yd. The change from broken stone to a mixture of broken stone and gravel therefore shows a considerable economy in the product.

More recently the use of broken stone was necessarily abandoned altogether, due to the failure of the contractor's rock crushing plant. In order not to delay the work, permission was granted to use the sand and gravel without any admixture of broken stone. In case of blocks made with mixed aggregate, as well as those made with sand and gravel only, the resulting concrete appears to be very much denser than that made when broken stone alone is used, and shows much less absorbing power.

With the blocks made with crushed stone alone, water will soon appear in the top joggles when the block is placed with its top surface a little distance above the water level. With the concrete blocks made of sand and gravel only, the blocks have stood for days in the lake with the

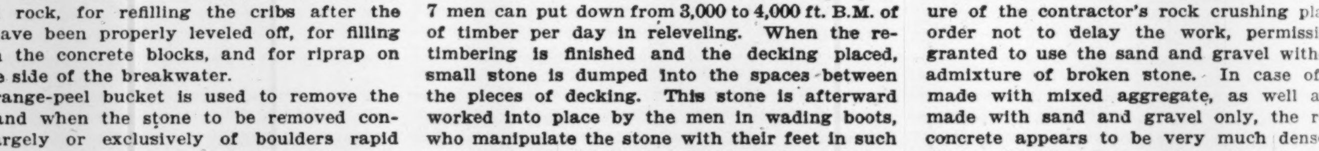

FIG. 2. SUCCESSIVE STAGES OF WORK IN REPLACING SUPERSTRUCTURE TO BREAKWATER, HARBOR BEACH, MICH.

water nearly to the top surface and no water whatever has appeared in the top joggles.

MONOLITHIC BLOCKS.—When work under the contract was begun it required 24 hours to build a single section, a monolithic block containing 185 cu. yds. of concrete. As a result of the experience gained and the increased skill of the men in doing the work the time required to mold the blocks has since been reduced to 7 hours.

During the season of 1905 44 monolithic blocks were made, containing 8,561 cu. yds. of concrete. To make this amount of concrete there were used 10,074 cu. yds. of aggregate, consisting of 8% crushed rock, 54% gravel, and 38% sand. The aggregate, therefore, exceeded the volume of the resulting concrete by 17.7%.

The general plan for molding the monolithic blocks was to build alternate sections. These were provided with anchor bolts to take and hold in place the intermediate blocks. For this purpose 3 railroad rails in 6-ft. lengths were used in the end of each block. (See Fig. 5.)

A part of the breakwater has been riprapped on the lake side with stone of appropriate size and weight, the slope of the riprap being nearly 45°. The action of the storm waves will flatten this somewhat, which will lengthen the slope and tend to modify the force of the waves.

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LICENSING SURVEYORS AND ENGINEERS CONNECTED WITH THE UTILIZATION OF WATER IN WYOMING.

Wyoming, both as a territory and a state, has shown remarkable progressiveness in its various measures for the control of the waters of the commonwealth. Those waters are regarded as public property and are being conserved in the public interests. They can be appropriated for private use only by the sanction of the state, and under the control of the state engineer. Irrigation is the chief use to which water is put in Wyoming, and where water is so valuable and so much depends upon the character of irrigation works it is of great importance to both the general public and individual irrigators that all the surveying and engineering pertaining to irrigation works should be properly done. The fact that any person could call himself an engineer, we are informed by Mr. Clarence T. Johnston, State Engineer of Wyoming, has caused many deceptions of the public, while through the same means "investors have been injured by the misrepresentation of irrigation works." As a result of demands from all parts of the state a law has been passed providing that engineers and surveyors connected with water appropriations or works for the utilization of water must secure a certificate stating that they belong to one or more of four classes. The section of the law covering this matter is as follows:

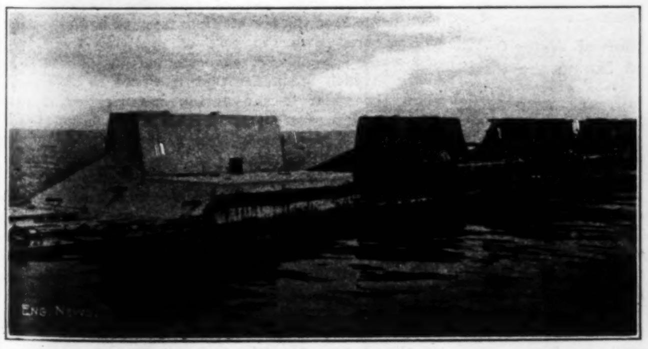

FIG. 5. ALTERNATE BLOCKS AS BUILT ON THE HARBOR BEACH BREAKWATER.

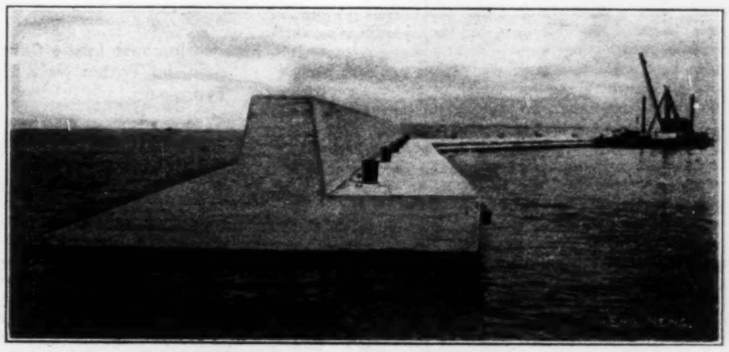

FIG. 6. THE FINISHED BREAKWATER AT HARBOR BEACH, MICH.

> Section 38. All engineers and surveyors who shall hereafter perform any field work preliminary to the preparation of an application for permit to use the water of the State, or who shall make surveys or do engineering work relative to the utilization or use of water, shall satisfy a board to be known as the Board of Examining Engineers, which shall consist of the State Engineer and two engineers of thorough training and experience, to be appointed by the Governor and serve without compensation, that they belong to one or more of the following classes: –
>
> 1. Land Surveyor (examination, plane surveying).
> 2. Topographic Engineer (examination, plane surveying and topographic surveying).
> 3. Hydraulic and Hydrographic Engineer (examination, plane surveying and hydraulics).

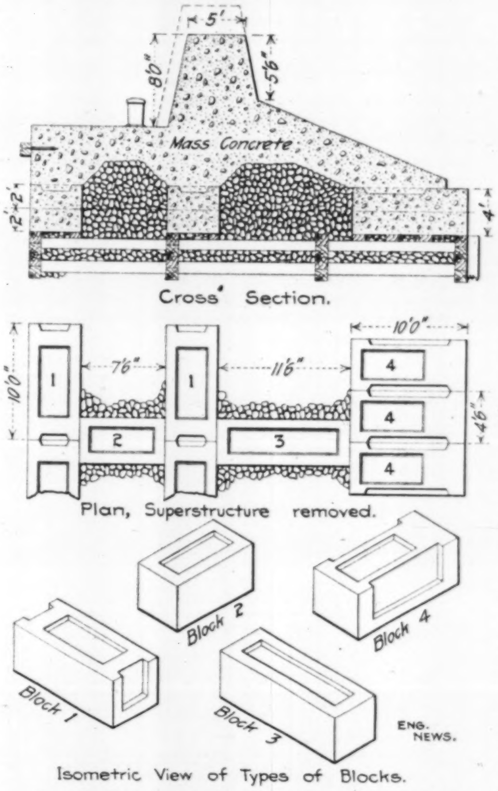

Fig. 3. Permanent Concrete Superstructure to Breakwater, Harbor Beach, Mich.

> 4. Construction and Designing Engineer (examination, plane surveying, design of irrigation works and structures and the computation of earthwork).
> 5. Administrative Irrigation Engineer (examination, plane surveying, hydraulics, construction work, irrigation law and practice).
>
> The Board of Examining Engineers may satisfy itself by conducting examinations or by investigations of the record, training and experience of those who may desire to qualify. In case the board is satisfied as to the standing of any applicant it shall issue a license, upon payment of a fee of five dollars which shall be applied to cover the expenses of said board; said license shall be signed by the president of the board and attested by the secretary under his seal. The Board of Examining Engineers shall in all cases make inquiry relative to the moral character of every applicant for a license, and no license shall be issued to any applicant who is incompetent, dishonest, intemperate or addicted to any habit which would, in the judgment of the Board, render him an unsafe employee of any citizen, corporation or association of the State. An engineer or surveyor who may qualify under any one or any number of the classes specified herein, who shall indicate by the character of the work he performs that he is not capable of carrying on such work as set forth in his license, or who becomes morally unfit to practice under any class, may be disqualified and his license revoked. The State engineer is hereby authorized to refuse to accept any and all work of those who do not avail themselves of this section.

Mr. Johnston expresses the belief that this legislation will meet present needs and "that the law will gradually be extended so as to cover a broader field."

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A STATE WATER SUPPLY COMMISSION FOR NEW Jersey is proposed by a bill introduced in the legislature of that state. The commission would consist of five citizens appointed by the Governor and would be "charged with a general supervision over all the sources of water supply, to the end that the same may be preserved for the benefit of the people of this state." Under the act no municipal corporation, water company nor person would hereafter have the right to take or condemn lands or water until the plans for the proposed works had been filed with and approved by the commission after an advertised public hearing. In passing on plans the commission would consider whether or not the proposed works were justified by public necessity, and whether such plans are just and equitable to other municipalities and to other inhabitants of this state, who may be affected thereby either through the taking of waters necessary for their use or through the reduction of the dry season flow of any stream to an amount which may cause unsanitary conditions or otherwise damage public or private interests, whether such damages are or are not of a nature which under existing laws would be recognized as entitling the injured parties to compensation.

The commission would be given power to require reports from all municipalities and water companies as to the amount of water diverted by them for water supply purposes, including power, the communities and population supplied, the rates charged, etc. Cities and companies would be required to keep accurate records by meters, or other approved methods, of the amount of water used, and to supply accurate information thereof to said commission. The commission shall also have power to make such investigations of the meters and records of said companies as may be necessary to determine all matters pertinent to the supervision and control of the water supply.

The act also makes two provisions for payments to the state for water diverted from streams and lakes by municipalities or private water companies: (1) For "water hereafter diverted in excess of the amount now being diverted"; the basis for payment under this clause is not stated. (2) For all water diverted in excess of 100 gals. per day per inhabitant, as shown by the census of 1905; the payment under this clause is to be fixed by the commission at not less than $1 nor more than $20 per 1,000,000 gals., and the commission would fix a low rate for stored flood waters and "increase the rate in case the dry season flow of the stream is encroached upon or diminished." One section of the bill, which evidently relates to proposed flood storage on the Passaic, provides that the commission, with the assistance of expert engineers, shall examine any plans for water storage hereafter made by any other state department, and report to the legislature as to the advisability of the proposed storage. For the purposes of this investigation $5,000 would be appropriated by the act under review.

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STEAM MOTOR CARS are being built at the shops of the Intercolonial Ry., at Moncton, N. B.; three are for service on its own lines and two for the Prince Edward's Island Ry. They will seat 40 passengers (12 in the smoking room), and are designed for a speed of 25 miles an hour on a 1% grade. Their principal dimensions are as follows:

Driving wheels	3 ft. 6 ins.
Wheelbase, steam truck	8 ft. 0 ins.
Cylinders	12 × 16 ins.
Boiler	Vertical
Steam pressure	180 lbs.
Heating surface, tubes	685 sq. ft.
Firebox	44 sq. ft.
Total	729 sq. ft.
Grate area	11¼ sq. ft.
Water in tank	600 gals.
Coal in bunker	1 ton

SOME NEW FACTS RELATING TO THE EFFECT OF METERS ON THE CONSUMPTION OF WATER.*

By WILLIAM S. JOHNSON,† M. Am. Soc. C. E.

For the past twenty years the advantages of selling water by meters have been much dicussed, until now there are but few connected with the management of water-works who question the desirability of having all services metered. There is much yet to be learned, however, as to the results to be accomplished thereby. The enormous saving of water and the consequent saving in expense which would be possible by the general use of meters have been repeatedly demonstrated. The cities of Brockton, Fall River and Providence, where meters have been in general use for many years, have been referred to time and time again as examples of what might be accomplished in other places. The English and German cities, with their still lower consumption, have also been frequently cited as examples of what ought to be accomplished in American cities.

During the past ten to twenty years great numbers of meters have been introduced, and now in many places the percentage of metered services is as great as in the cities which have so long served as examples, but the predicted saving in water has not been accomplished. On the contrary, an examination of the figures of consumption shows that the rate of increase in the use of water in Brockton, Fall River and Providence is greater than the rate of decrease in many of the places where meters have recently been introduced, indicating that if the consumption in these other cities ever becomes the same as that of Brockton, Fall River and Providence the latter places are likely to meet the others half way.

Notwithstanding the great increase in the use of meters all over the country, the average quantity of water consumed per person is increasing at a rapid rate. The increase in the consumption of water during the past ten years is shown in the accompanying diagram (Fig. 1), which gives the average daily consumption in a large number of cities outside of New England and in the principal New England cities and towns. On the same diagram is shown the consumption of water in those places inside and outside of New England where, in 1895, at the beginning of the period, more than 25% of the services were metered and the consumption in those places where the percentage of metered services has increased more than 25% during the ten years—that is, where there has been a general introduction of meters. The startling feature of the diagram is the apparent failure of meters to reduce the consumption of water, or even check the increase. During this period of ten years there were installed in the places used in making these curves more than 250,000 meters. In the places used in making the averages outside of New England the percentage of metered services in 1895 was 13, while in 1905, at the end of the ten years, it had increased to 38. During this time there was an increase in the per capita consumption of water of 11 gals. per day. In New England the percentage of metered services in 1895 was 40, increasing in the ten years to 60, while the consumption increased 15 gals. per person per day.

In those places outside of New England where more than 25% of the services were metered at the beginning of the period under consideration the increase has been 14 gals. per day. In those places where there has been a very general introduction of meters during the period there has been a decrease of 1 gal. per person per day. In New England the increase in the consumption in those places which were very generally metered in 1895 has been kept down to 6 gals. per person per day, while in those places where the percentage of metered services has increased more than 25 during the ten years the increase has been 11 gals. per person per day.

In Table I. are given all of the available statistics in relation to the consumption of water and the percentage of metered services, in 1905, in American cities having a population of more than 25,000. In Table II. are given similar statistics for places having a population of less than 25,000, most of these places being in the State of Massachusetts. The population of places in Massachusetts is the census population; outside of Massachusetts, where the latest available census is that for 1900, the population has been estimated by assuming that the rate of increase from 1900 to 1905 has been the same as that from 1890 to 1900. In practically all cases, the population used is the total population of the city supplied. The only exceptions to this rule are where a large community outside of the city limits is supplied. This figure does not in all cases represent the actual population using the water, as in some of the places there is a considerable percentage of the population to which the public water supply is not available. On the other hand, in summer resorts, and in cities which are business centers for the surrounding population, the population actually using the water is much larger than the census population. It is found that the estimates of the population actually supplied with water are in many cases very inaccurate and better comparative results are obtained by taking the total population of the places supplied. The figures for consumption and for meters have been obtained in all cases either from printed reports or from the officials in charge of the water-works.

To show the relation between the percentage of metered services and the consumption Table III. is presented, giving the average consumption in those places having certain percentages of services metered.

In order to show the immediate effect of the introduction of meters, Table IV. has been prepared.

As would naturally be expected, the immediate effect of the rapid introduction of meters is a reduction in the quantity of water used; but while the introduction of more than 25% of metered services within 5 years reduces the consumption, the introduction of the same number of meters in a period of 15 years does not prevent a substantial increase in the consumption. In other words, it would appear that after a certain amount of waste has been checked, the increase in the consumption continues, notwithstanding the use of meters.

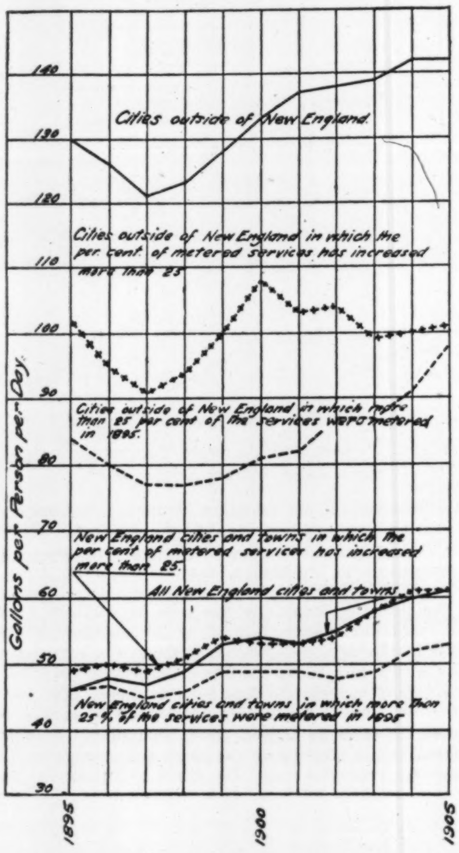

Fig. 1. Increase in the Consumption of Water Outside and Within New England During the Past Ten Years.

The accompanying diagrams show graphically the relation between the percentage of metered services and the per capita consumption of water in several typical cities.* In the case of Richmond is shown the effect of the introduction of meters on an abnormally large consumption. The great reduction thus effected continues for a few years, until the principal sources of waste are discontinued, or possibly until the vigilance of the water department is somewhat abated, and then the increase in consumption again begins at substantially the same rate as before meters were introduced.

In Needham and Attleborough the introduction of meters appears to have failed to check the increase in the consumption. The last three diagrams [cities named further on] show cases where the effect of meters may be overestimated, as there are other conditions which affect the quantity of water consumed. It is well known that where the water supply is of poor quality a much greater quantity is used than where the water is clear and colorless, and this is especially the case where the water contains an excessive amount of iron or large numbers of organisms, since faucets are allowed to run for a long time in an attempt to make the water clear. In the places represented in these diagrams water of poor quality was supplied up to the time when the reduction in the consumption began. In the case of Reading the water contained such large quantities of iron as to make it practically unfit for domestic purposes. After the construction of a filter to remove the iron, the consumption of water was reduced very materially, and the greatest reduction occurred the year before the general introduction of meters. In Lowell and Lawrence meters were being rapidly introduced for many years before the reduction in consumption began, and this reduction occurred immediately after the introduction of a better water supply.

Enough has been shown to indicate that the introduction of meters in places where the consumption of water has been large has not in most cases produced the results which have been anticipated. What, then, has been accomplished by meters and what effect are they likely to have on the consumption of water in the future?

In the consideration of what meters will accomplish, it is convenient to divide the use and waste of water into the following classes: (1) Water used or wasted in houses. (2) Water used in factories and for mechanical purposes. (3) Water used for public purposes, such as watering streets, supplying drinking fountains, etc. (4) Leakage from street mains, distributing reservoirs and service pipes.

The use and waste of water in houses includes water which leaks from defective pipes and fixtures, or which is wasted by allowing the water to run continuously, and water which is intentionally drawn from the faucets or other fixtures. The quantity lost through defective plumbing fixtures is, in many cases, very large, and it is here that the house meter is most useful. Unfortunately, however, statistics in regard to the quantity actually lost are impossible to obtain. Efficient inspection will do much toward preventing waste in this way, but increased water bills caused by leaking plumbing are more effective than the most efficient inspection. The quantity of water wasted by intentionally leaving faucets open is probably much smaller than is generally believed.

The line between the legitimate use and the waste of water is not well defined, but water which is intentionally drawn from the faucets or other fixtures, whether or not more than actually necessary for the purposes for which it is drawn, may be said to be legitimately used. Under this definition the water which is used by allowing the faucets to run during cold nights to prevent freezing may be classed under legitimate use. Investigations have shown that the actual quantity of water consumed in this way is comparatively small.

Table V. gives the relation which the consumption in each month bears to the average consumption, together with the average rainfall and temperature, in Massachusetts.

It will be seen that the difference between the consumption during the coldest months and the consumption during April, the month of minimum consumption, is only 3%. This excess of consumption generally comes in a few days, but it comes at a time when the sources of supply are least affected by a great draft upon them, except in cases where water is drawn from large storage reservoirs, and it comes at a time when the consumption is naturally small, so that the plant will not be called upon to do an excessive amount of work, as compared with the work required during the high consumption. The cost of supplying the extra water required to keep the faucets from freezing is insignificant, as compared with the cost of repairing frozen pipes, and while I would not advocate putting plumbing in a house in such a manner that it would be necessary to allow the water to run during cold weather, I cannot criticise very severely the householder who uses a few cents' worth of water to save a plumber's bill of many dollars, and if the water is sold at meter rates such use of the water is certainly legitimate. The quantity of water used for this purpose is undoubtedly greater than is necessary, and is reduced by the introduction of meters, but the total saving is an exceedingly small proportion of the consumption.

The quantity of water actually used for strictly domestic purposes is increasing at a very rapid rate. In the first place the number of fixtures in the houses is increasing. This is especially noticeable in the less expensive houses, which now contain many plumbing fixtures where formerly a single faucet was all that would be provided. Not only is the number of fixtures increasing rapidly, but the quantity of water used by each fixture is increasing. The modern sinks, water-closets and bath tubs require very large quantities of water. The faucets and pipes are made of such a size that they deliver water much more freely, which tends to increase the quantity used. In the State House at Boston the water closets are so constructed that every time that a closet is flushed 5 gals. of water enter the sewer. The wash basins are such a shape and size that in order to obtain a sufficient depth of water for washing the hands it is necessary to draw from 1½ to 2 gals., and the basins hold when full to the overflow 2½ gals. It is easy to figure that a person of ordinary cleanliness, with such plumbing fixtures as those in the State House and with a modern large-sized bath tub, will use a much larger quantity of water than that allowed the average person in many of the estimates which are made of the quantity of water necessary for a water supply.

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*A paper, somewhat condensed, read before the New England Water-Works Association on March 13, 1907. The paper, with discussion, will be printed in the June number of the Journal of the Association. Further discussion is invited, and should be sent as soon as feasible to Charles W. Sherman, Editor, 14 Beacon St., Boston, Mass.

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[*Besides the six diagrams here reproduced, which include all those specifically mentioned, seven others accompanied the paper—Brockton, Mass.; Fall River, Mass.; Pawtucket, R. I.; Providence, R. I.; Woonsocket, R. I.; Yonkers, N. Y., and Grand Rapids, Mich.—and will appear in the Journal of the New England Water-Works Association for June, 1907.—Ed.]

Many interesting facts have been published from time to time in regard to the actual consumption of water in houses of different classes, as indicated by meter readings. Table VI. gives a summary of recent studies made in Fall River, a manufacturing city where the consumption is 42 gals. per person per day, and in Needham, a residential town where the consumption is 79 gals. per day. Meters are very generally used in both places.

In each case, Class A represents the most expensive houses, surrounded by lawns, and the last class includes some of the cheapest tenement houses. When it is considered that a large proportion of the houses in Fall River would be included in the last classes, while in Needham a comparatively small proportion is included in the last class, a considerable portion of the difference in the consumption of water in these two places is accounted for.

To further illustrate the difference in the consumption of water in different classes of cities or towns Table VII, is introduced, which gives the average consumption of water in the cities and towns of Massachusetts, arranged in groups.

The quantity of water used in manufacturing differs greatly in different places, due to differences in the character and location of the town, the character of the factories and the attitude which the town takes in regard to supplying water to the factories. The quantity used in factories for sinks and water closets has been determined from a study of the meter readings in a large number of factories in various cities, and is found to be fairly uniform in places where water used for this purpose is metered. [A table, not reproduced, shows that in 20 metered factories, with from 50 to 2,093 operatives each, the amount of water used for sinks and water closets ranged from 6.6 gals. per day in a factory with 525 operatives to 2.1 in one with 120 operatives. The average for the 20 factories was 4 gals.—Ed.]

The quantity used in many factories where the water is not measured is very much in excess of these amounts, as the water is allowed to run continuously through both sinks and water closets.

The quantity of water used in manufacturing processes or for mechanical purposes is frequently large in comparison with the quantity used for strictly domestic purposes, and in some places the use of water by factories is encouraged by making only nominal charges for it, the smaller consumers being in such cases taxed for the support of the factories.

Table VIII. contains interesting statistics in regard to the largest metered consumers of water in various cities and towns.

Upon studying this table some of the inequalities in the figures in consumption are explained. If the amount consumed by the ten largest consumers is deducted from the total consumption, the amount used by the remaining consumers in the different cities and towns is much more nearly the same. If 20 consumers had been included there would be a still greater similarity in the quantity used by the remaining consumers. It will be seen that in those places which have been so frequently referred to, namely, Brockton and Fall River, there are no very large consumers of water. In Brockton the shoe shops use but little water and in Fall River the water used by the factories is obtained from independent sources. In all of the places included in the table water is paid for at meter rates, and it is evident that the further introduction of meters in places like Norwood, Taunton and Watertown is not likely to reduce the consumption to that of North Attleborough and Reading.

Very little is known about the quantity of water used for public purposes. Statistics obtained from several places in Massachusetts indicate that the quantity so used amounts to from 4 to 10 gals. per person per day.

The quantity of water lost by leakage from street mains, distributing reservoirs, service pipes, etc., is in many cases excessive. The best estimate of this quantity is obtained from a comparison of the quantity of water drawn from the sources of supply with the quantity of water passed through meters in those places where practically all of the services are supplied with meters.

Table IX. indicates that practically half of the water which is drawn from the sources of supply is unaccounted for by the meters. This discrepancy is doubtless due in part to errors in the registration of the meters and in part to errors in the rating of the pumps

TABLE I.—AVERAGE DAILY CONSUMPTION OF WATER AND PERCENTAGE OF METERED SERVICES IN 1905 IN CITIES HAVING A POPULATION OF MORE THAN 25,000.

City and population (1 = 1,000)	Per cent. services.	Daily per capita consumption.	City and population (1 = 1,000)	Per cent. services.	Daily per capita consumption.
Albany, N. Y. (94)..	15	211	Memp's, Tenn. (121)	20	100
Altoona, Pa. (43)...	3	112	Milw'kee, Wis. (326)	80	91
Atlanta, Ga. (102)..	100	65	Min'p's, Minn. (222)	47	76
Atlantic City, N. J. (35)	78	147	Nashville, Tenn. (83)	52	148
Auburn, N. Y. (33)..	6	172	Newark, N. J. (278)	44	117
Augusta, Ga. (43)..	0	150	New Bedford, Mass. (74)	23	95
Bay City, Mich. (28).	33	122	New Britain, Conn. (31)	6	145
Bayonne, N. J. (40).	100	95	Newcastle, Pa. (37).	1	94
Boston, Mass. (595).	5	151	New Haven, Conn. (121)	3	168
Bri'g'p't, Conn. (82)	5	210	Newport, Ky. (30)..	20	37
Br'ckt'n, Mass. (48)	90	38	Newton, Mass. (37).	86	58
Buffalo, N. Y. (401).	3	324	Norfolk, Va. (53)...	0	125
Butte, Mont. (40)...	7	100	Omaha, Neb. (84)...	59	110
Camb'ge, Mass. (97)	19	92	Oshkosh, Wis. (31).	15	76
Camden, N. J. (85)..	3	155	Paterson, N. J. (119)	37	87
Canton, O. (33)....	2	125	Pawtucket, R. I. (79)	81	104
Cedar Rapids, Ia. (29)	40	83	Philadelphia, Pa. (1,417)	1	230
Charl'st'n, S. C. (56)	2	57	Pittsburg, Pa. (363).	0	210
Chelsea, Mass. (37).	10	110	Providence, R. I. (213)	86	68
Chester, Pa. (41)...	20	75	Quincy, Ill. (39)....	53	31
Cincinnati, O. (340).	12	130	Quincy, Mass. (28)..	3	109
Cleveland, O. (442).	68	137	Racine, Wis. (33)...	51	90
Columbus, O. (144).	76	110	Reading, Pa. (89)...	7	128
Covington, Ky. (46)	100	51	Richmond, Va. (87).	44	150
Davenport, Ia. (39)..	50	81	Roch'st'r, N. Y. (177)	41	88
Dayton, O. (97).....	70	70	Rockford, Ill. (35)..	19	95
Detroit, Mich. (326).	9	188	Saginaw, Mich. (40).	8	200
Duluth, Minn. (63)..	41	77	St. Jos'ph, Mo. (128)	20	58
Erie, Pa. (59).......	2	179	St. John, N. B. (45)	3	143
Evansville, Ind. (63)	0	125	St. Louis, Mo. (637)	7	92
Everett, Mass. (29).	2	89	St. Paul, Minn. (178)	38	56
Fall River, Mass. (106)	97	42	Salt Lake City, Utah (58)	2	303
Glouc'st'r, Mass. (26)	5	53	San Antonio, Tex. (61)	10	132
Grand Rapids, Mich. (101)	29	123	San Francisco, Cal. (365)	21	96
Har's'b'g, Pa. (56)..	73	171	Schenectady, N. Y. (38)	0	99
Hartford, Conn. (93)	98	66	Seattle, Wash. (100)	12	100
Hoboken, N. J. (67).	69	115	Sioux City, Ia. (31).	61	35
Holyoke, Mass. (50)	8	120	Som'ville, Mass. (69)	19	89
Ind'n'p'l's, Ind. (196)	10	82	So. Bend, Ind. (43)..	8	102
Jackson, Mich. (27).	26	74	Springfield, O. (41).	12	85
J'cks'n'v'l, Fla. (34)	59	67	Superior, Wis. (41)..	31	57
Johnstown, Pa. (43).	1	159	Tacoma, Wash. (39).	10	72
Kan. City, Kan. (58)	45	113	Taunton, Mass. (31).	46	62
Kan. City, Mo. (179)	38	73	Terre Haute, Ind. (40)	19	70
Kn'xv'le, Tenn. (38)	36	67	Toledo, O. (157)....	70	75
La Crosse, Wis. (31).	5	96	Toronto, Can. (270).	4	93
Lancaster, Pa. (46).	20	130	Troy, N. Y. (61)....	4	248
Lawrence, Mass. (70)	88	43	Utica, N. Y. (63)...	98	59
Lexington, Ky. (29).	98	58	Waltham, Mass. (26)	10	70
Lincoln, Neb. (33)..	100	40	Wilm'gton, Del. (84)	21	102
Los Angeles, Cal. (129)	31	120	W'ns'ket, R. I. (32).	85	37
Louisville, Ky. (227)	8	81	Wor'st'r, Mass. (128)	95	75
Lowell, Mass. (95) .	69	58	Yonkers, N. Y. (56).	99	115
Lynn and Saugus, Mass. (83)	30	59	York, Pa. (40)......	3	63
Malden, Mass. (38)..	78	53			
McKeesport, Pa. (41)	23	115			
Manchester, N. H. (63)	72	52			

TABLE II.—AVERAGE DAILY CONSUMPTION OF WATER AND PERCENTAGE OF METERED SERVICES IN 1905 IN CITIES AND TOWNS IN MASSACHUSETTS HAVING A POPULATION OF LESS THAN 25,000.

City or Town.	Per cent. services.	Daily per capita consumption.	City or Town.	Per cent. services.	Daily per capita consumption.
Andover (7).........	78	68	Methuen (9)	78	43
Arlington (10)......	22	81	Middleborough (7)..	47	38
Attleborough (13)...	100	43	Milford and Hopedale (14)	19	65
Avon (2)............	1	40	Milton (7)	100	46
Ayer (2)............	55	53	Montague (7)	4	81
Belmont (4).........	100	61	Nahant (1)	18	149
Beverly (15)........	3	87	Nantucket (3)	0	56
Billerica (3).......	59	28	Natick (10)	58	56
Braintree (7).......	37	87	Needham (4)	95	66
Bridgewater and East Bridgewater (10)	9	21	Newburyport (15)...	2	51
Brookline (23)......	93	95	North Andover (5).	74	43
Canton (5)..........	47	63	N. Attleborough (8).	100	40
Clinton (13)........	86	41	Norwood (7)	55	64
Danvers and Middleton (10)...........	2	81	Orange (6)	64	27
Dedham (8).........	37	135	Peabody (13)	4	133
Easton (5)..........	43	24	Reading (6)	89	28
Fairhaven (4)	45	79	Revere (13)	4	80
Falmouth (3)	1	73	Rockport (4)	2	81
Foxborough (3)	46	63	Shirley (2)	99	13
Franklin (5)	2	44	Stoneham (6)	2	81
Gardner (12)	6	80	Stoughton (6)	59	64
Groton (2)	99	28	Tisbury (1)	1	63
Hyde Park (15).....	34	77	Walpole (4)	47	86
Ipswich (5)	30	26	Ware (9)	100	41
Lexington (5))	2	66	Wareham (4)	0	10
Manchester (3)	100	94	Watertown (11) ...	94	70
Mansfield (4)	33	49	Webster (10)	48	34
Marlboro (14)	59	41	Wellesley (6)	100	47
Maynard (6)	78	45	Weston (2)	81	31
Medford (20)	8	98	Whitman (7)	54	25
Melrose (14)	3	112	Winchendon (6)	97	18
Merrimac (2)	100	28	Winthrop (7)	2	114
			Woburn (14)	2	103

TABLE III.—AVERAGE PER CAPITA WATER CONSUMPTION IN CERTAIN CITIES AND TOWNS, GROUPED ACCORDNG TO PERCENTAGE OF METERED SERVICES.

	Cities over 25,000 population		Cities and towns under 25,000 population	
Per cent. services metered.	Number.	Consumption gals.	Number.	Consumption, gals.
1 to 10	34	146	26	77
11 to 25	23	97		
26 to 50	18	89	12	63
51 to 75	14	89	9	45
76 or more	19	72	22	48

TABLE IV.—INCREASE IN THE DAILY PER CAPITA CONSUMPTION OF WATER IN CITIES AND TOWNS DURING THE PERIODS FROM 1890 TO 1905, AND FROM 1900 TO 1905, COMPARED WITH THE INCREASE IN THE PERCENTAGE OF METERED SERVICES DURING THE SAME PERIODS.

	1890-1905		1900-1905	
Inc. in percentage of metered services	Number of places	Inc. consumption gals.	Number of places	Inc. consumption gals.
Less than 10	27	36	95	7
10 to 25	25	10	33	1
25 to 50	16	9	12	6*
More than 50	11	14	4	17*

*Decrease.

TABLE V.—PER CENT. WHICH MONTHLY CONSUMPTION IS OF THE AVERAGE MONTHLY CONSUMPTION, TOGETHER WITH THE AVERAGE RAINFALL AND TEMPERATURE.

(Average of Ten Years, 1896 to 1905.)

Month.	Per cent.	Rainfall, ins.	Temp., deg. F.
January	90	3.68	23.9
February	92	3.98	24.3
March	89	4.77	34.9
April	87	3.86	45.6
May	100	3.18	57.2
June	113	3.60	64.5
July	124	3.85	70.7
August	118	3.97	67.6
September	108	4.12	61.4
October	96	3.35	50.9
November	90	3.34	38.7
December	92	3.74	27.7

TABLE VI.—PER CAPITA CONSUMPTION OF WATER IN HOUSES OF DIFFERENT CLASSES IN FALL RIVER AND IN NEEDHAM.

Class.	Number of persons.	Galls. per day.	Persons per Water closet.	Persons per Bathtub.
		Fall River.		
A	44	49.6	1.6	2.6
B	160	23.7	2.5	4.3
C	550	13.2	3.9	8.3
D	792	12.2	7.6	*
		Needham.		
A	68	71	3	3
B	73	20	5	5
C	131	9	9	10

*No bath tubs.

TABLE VII.—AVERAGE DAILY PER CAPITA CONSUMPTION OF WATER DURING EACH MONTH OF 1905 IN CITIES AND TOWNS, ARRANGED IN GROUPS.

			Average of			
Month.	Boston.	Metropolitan district.	23 suburban cities and towns.	14 large manufacturing cities.	37 small cities and towns.	12 summer resorts.
Jan.	165	137	77	70	48	67
Feb.	175	147	85	74	53	75
Mar.	152	127	77	69	50	65
Apr.	140	117	73	65	46	65
May	144	121	79	68	52	89
June ...	146	123	79	70	53	109
July	151	131	88	72	58	150
Aug	148	127	79	69	56	131
Sep.	147	126	75	65	50	101
Oct.	145	124	73	65	47	74
Nov.	144	122	70	64	46	61
Dec.	153	129	71	64	45	65
Year	151	128	77	68	50	88

TABLE VIII.—USE OF WATER BY LARGEST CONSUMERS.

	Average daily consumption.		Quantity used by ten largest consumers.		
	gallons.				
City or town.	Total	Per person	Total	Per person	Per cent. total consumption
Andover	484,000	73	61,800	9	12.8
Attleborough ...	641,000	49	62,100	5	9.7
Brockton	1,993,000	40	166,100	3	8.3
Clinton	543,000	42	146,100	11	26.9
Fall River	4,478,000	42	444,300	4	9.9
Lawrence	3,308,000	46	335,800	5	10.2
Lowell	5,084,000	54	189,900	2	3.7
Malden	2,000,000	51	113,100	3	5.7
Marlborough	554,000	39	98,600	7	17.8
Newton	2,223,000	59	115,100	3	5.2
N. Andover	202,000	43	27,400	6	13.6
N. Attleborough.	282,000	35	15,000	2	5.3
Norwood	403,000	58	108,600*	16*	26.9*
Reading	147,000	25	7,300	1	5.0
Taunton	1,915,000	62	388,900	13	20.3
Watertown	771,000	67	134,700	12	17.5
Wellesley	273,000	43	24,300	4	8.9
Worcester	9,193,000	71	1,511,700	12	16.4

*Eight largest consumers.

TABLE IX.—RELATION BETWEEN THE QUANTITY OF WATER PASSED THROUGH METERS AND THE TOTAL QUANTITY OF WATER PUMPED IN 1905 IN CERTAIN CITIES AND TOWNS IN WHICH THE SERVICES ARE LARGELY PROVIDED WITH METERS.

City or town.	Per cent. of metered services.	Total pumpage, 1905, gals.	Metered, gals.	Per cent.
Attleborough ..	100	200,753,000	94,728,000	47
N. Attleborough	100	150,473,000	51,948,000	45
Wellesley	100	105,503,000	55,014,000	52
Ware	100	128,539,000	84,121,000	65
Yonkers, N. Y.	99	2,334,459,000	1,100,884,000	47
Fall River....	97	1,608,652,000	956,168,000	59
Winchendon ..	97	35,446,000	16,154,000	45
Madison, Wis.	97	537,187,000	165,951,000	31
Needham	95	103,487,000	26,012,000	25
Worcester ...	95	3,517,397,000	1,881,254,000	53
Watertown ...	94	287,605,000	153,676,000	53
Brockton	90	732,083,000	416,188,000	57
Lawrence	88	1,094,881,000	570,736,000	52
Clinton	86	197,938,000	104,277,000	53
Newton	86	785,222,000	510,000,000	65
Burlington, Vt.	79	385,443,000	208,139,000	54
Andover	78	164,151,000	54,423,000	33
Malden	78	737,127,000	289,262,000	39
N. Andover...	74	72,170,000	23,557,000	33
Lowell	69	1,998,929,000	801,401,000	40
Cleveland, O..	68	22,053,442,000	10,780,154,000	49

where the quantity drawn from the sources is determined by the pumping records. There is also, in many of these places, a large quantity of water which is used for street sprinkling and for drinking fountains and similar public uses which is not measured, but after allowance has been made for all of these errors and uses, there still remains a large quantity of water which is not accounted for which must be attributed to leakage in the system. To whatever this discrepancy between the quantity drawn from the sources and the quantity actually used is due, whether to the use of the water in the streets or to leakage, it is evident that it is not affected by the use of meters. The quantity thus unaccounted for in the places included in the table amounts to a per capita consumption of from 14 to 70 gals. per day.

In practically all of the places included in the foregoing tables the water supply is obtained by pumping, as it is unfortunately only in these places that any knowledge can generally be obtained as to the quantity of water used. In only a few cases where water is supplied by gravity are there any means of measuring the water, and it is safe to say that the consumption in places where nothing is known as to the quantity of water consumed is much greater than in those places where such records are kept. It is undoubtedly a fact that in some cases almost as much would be accomplished by the introduction of large meters on the main of supply as by the introduction of house meters. In this connection I can do no better than to quote from a statement made in 1900 by Mr. X. H. Goodnough, Chief Engineer of the Massachusetts State Board of Health:

> In cases where water is supplied by gravity it is generally considered unnecessary and often a waste of money to attempt to make any continuous and approximately correct record of the quantity of water used. There is no doubt, however, that in many such cases a knowledge of the excessive use of water would lead to a great reduction in waste and to a saving in the cost of construction and operation of the works far greater than the expense of making the necessary measurements.

A good illustration of the value of a knowledge of the quantity of water used is found in the experience of the city of Holyoke, where meters were recently introduced on the main lines of supply. It was found upon reading these meters that the average daily consumption of water in the city was 144 gals. per person. Upon making this discovery steps were immediately taken to ascertain where the water was going, and by vigilant inspection during a period of a few months the consumption was reduced to 103 gals. per day, the actual saving of water amounting to over 2,000,000 gals. per day. During the investigations which were made it was found that large quantities of water were being stolen, and it is said that the revenue has been increased very materially by these discoveries, directly attributable to the introduction of large meters on the supply lines.

From a consideration of the foregoing facts it is evident that disappointment is inevitable in the case of many cities and towns where meters are being introduced. In one town which has recently come to my notice, the population is about 10,000 and the per capita consumption is from 96 gals. per day in winter to 128 gals. per day in summer, and the general introduction of meters has been recommended to obviate the necessity of obtaining an additional supply of water. In this town one factory uses 200,000 gals. of water per day, the water being furnished under a 50-year contract, the town to receive 0.5-ct. per 1,000 gals. This amounts to 20 gallons per person per day. There are other factories in the town which are supplied with unknown but probably smaller amounts of water. The town uses nothing but cement-lined, wrought-iron mains, which are laid in a sandy soil where leaks of considerable size would remain undetected for a long time. There is also a very large summer population in the town, which increases the draft during the summer months. While the general introduction of meters in this town would undoubtedly result in the saving of water and should be unhesitatingly recommended, it is certain that results like those obtained in the cities of Brockton, Fall River and Providence are not possible, and it is doubtful if the consumption in this particular town can be reduced to less than from 80 to 90 gals. per person per day.

I do not wish to be understood to question in the least the advantages of selling water by measurement. I am convinced that it is the only proper method of selling water and that it should become universal. Neither do I question that a great saving in the use of water can be made by the introduction of meters. The most recent experience, however, shows conclusively that the extravagant claims which have been made as to the reduction in the quantity of water made possible by the introduction of meters are not fulfilled, and I have endeavored to show by an analysis of the figures some of the reasons why the predicted results have not been accomplished and why they are not likely to be accomplished with the present tendency toward a greater use of water for almost every purpose. I have also endeavored to show that a prediction as to what meters will accomplish in any particular case should not be made without some knowledge of the principal sources of use and waste to determine how much of the consumption is susceptible of regulation by meters.

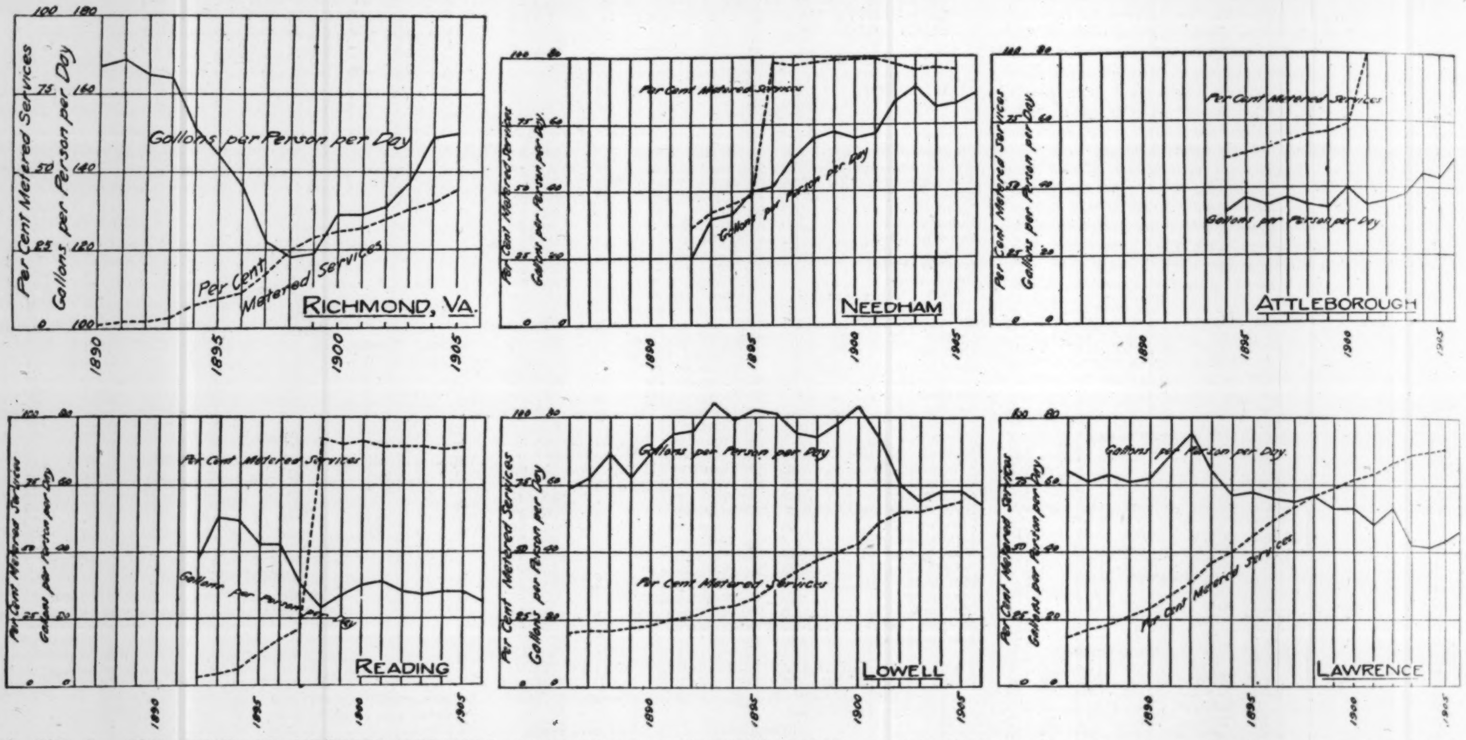


FIG. 2. PER CENT. OF METERED SERVICES AND AVERAGE DAILY PER CAPITA CONSUMPTION OF WATER IN RICHMOND, VA., NEEDHAM, ATTLEBOROUGH, READING, LOWELL AND LAWRENCE, MASS., 1890, 1895, 1900 and 1905.

DISCUSSION.

Mr. George A. King, Superintendent of Water-Works, Taunton, Mass., called attention to the fact that loss of registration after a few years, due to accumulation of rust and sediment, and occasionally to broken parts, may account for some of the failure to keep consumption at a low point. Customers who find that their bills are decreasing are likely to become more lavish in the use of water.

President John C. Whitney, Water Commissioner of Newton, asked whether the introduction of sewers might not account for some of the peculiarities shown in the diagrams. Mr. Johnson replied that this consideration had been studied, but that although in some cases the effect could be seen, in others it could not.

Mr. Charles W. Sherman, of Boston, stated that most of the places included in the tables and diagrams are of moderate size, and that probably at the beginning of the period covered by this study the water mains did not serve the entire population. Thus the gradual extension of the system would show a larger consumption of water per capita of population as time goes on, even though no more water per consumer should actually be used.

Mr. Walter H. Richards, of New London, Conn., reported a case in an adjoining town where a large service was metered, but the superintendent suspected the record for some reason, although the meter was new, and connected a second meter tandem with the first. The second meter recorded 39% less than the first; so a third meter was connected, all the water used passing through all three meters. The third showed 25% less registration than the second. The three meters were then removed and tested, and *all* were found correct. No explanation for these results has yet been found. Mr. Richards suggested that peculiarities in the meters may account for some of the remarkable results shown in the tables and diagrams.

Mr. John F. J. Mulhall called attention to the fact that the slip of pumps is not infrequently found to be as high as 20 to 30%, and as figures of total consumption are usually based on pumping records, they may be materially in error from this source. Such an error would increase with lapse of time, showing an apparently increasing total consumption.

Mr. Dexter Brackett, Chief Engineer of the Metropolitan Water-Works, emphasized the matter of increasing slip. At the average small works, with direct-acting steam pumps, the slip is more likely to be greater than 10% than below this figure. He took issue with Mr. Johnson in the latter's statement that waste from allowing fixtures to run to prevent pipes from freezing during cold weather was small, and could be considered a legitimate use. As compared with the week ending Dec. 1, 1906, that ending March 2, 1907, showed a waste of from 40,000,000 to 50,000,000 gals. per day from this cause in the Metropolitan District, or more than a third of the average daily consumption. This water costs the District $50 per 1,000,000 gals., and is sold to the consumer for $200. Meters have a very notable effect on the cold weather waste. Thus, in Chelsea, where there are few meters, the consumption during the latter (colder) week was about twice that of the earlier, while in Milton, where every service is metered, the consumption was actually less during the colder week.

Mr. R. J. Thomas, Superintendent of the Lowell Water-Works, said that the consumption of water there in 1906 was the lowest for 17 years, and that the reason was the extension of the use of meters. A thousand meters were set in 1900, and all new services must now be metered. He did not think that the improvement in quality of the supply had much if any effect. The waste from leaving faucets running to prevent freezing is enormous.

The discussion was also participated in by Messrs. F. F. Forbes, of Brookline; Frank L. Fuller, of Boston; George Cassell, of Chelsea; F. H. Hayes, of Boston; E. S. Larned, H. V. Macksey, X. H. Goodnough, Chief Engineer Massachusetts State Board of Health; and J. C. Gilbert, of Whitman. Practically all of them agreed that the cold weather waste was very great, and many of them seemed to feel that, in spite of Mr. Johnson's closing declaration that he believed the only proper way to sell water is by meter, the effect of this paper would be to hinder the introduction of meters, especially where, as is often the case, it is necessary to overcome the prejudices of city councils.

A MASONRY ARCH BRIDGE AT ORLEANS, FRANCE.*

The devotion of the French engineer to the masonry arch is again shown in the recently completed bridge across the Loire at Orleans. This bridge is 1,088.8 ft. in length, 44.13 ft. wide, and consists of seven masonry arches each of 143.87 ft. span and 19.03 rise, with a thickness at crown of 4.10 ft. and at haunches of 4.78 ft. There is little in its design to distinguish it from the great number of masonry arches already built except the high ratio between the span and rise and a concrete steel spandrel arch construction, to provide for expansion.

With the exception of the Turin Bridge across the Dora Riparia, span 147.6 ft., rise 18.05 ft. (ratio 1 to 8.18) and the Boucicault† and Mort arches in France, each with a span of 131.2 ft. and a rise of 16.4 ft. (ratio 1 to 7.9) the Orleans arches have the largest ratio of span to rise (ratio of 1 to 7.5) of any purely masonry no-hinged arch over 120 ft. span.

The arch ring is a transcendental curve, approximating a circle, called by its designer a "catenoid." It is designed to approach, as near as would be consistent with a line of beauty, the curve of pressure of the loaded arch. The thickness of the ring varies inversely as the cosine of the angle that the middle fiber makes with the horizontal, thus insuring the same pressure at all points along the arch ring.

In order to avoid the usual cracks in the spandrel arches due to expansion a method, unique in masonry arches, was devised. The expansion is provided for by tying the whole spandrel system back into a detached portion of the pier or abutment (shown in the half section of Fig. 1). This detached wall, being of a thin construction, can bend and by means of the tie follow the movements of the spandrels when the large arch moves under a change of temperature. The tie is made by placing at intervals of about 5½ ft. transverse to the line of bridge 1-in. round iron rods, encased in concrete in groups of three, as shown in Fig. 2. At each spandrel wall and at the pier (or abutment) these longitudinal rods are bonded to vertical and transverse rods imbedded in the masonry of the spandrel walls. The concrete is about 1 ft. wide on the arch proper, widening to about 3 ft. over the spandrel walls. Between the concrete arches the ordinary masonry spandrel arch construction is followed. Fig. 3 shows in a better way than drawings or description the method of laying these bonding ties. Evidently concrete was used instead of stone around these tie rods merely because it affords a better medium in which to place the iron. The whole spandrel construction is separated from that portion of the bridge which will remain stationary under arch ring movement by a joint, shown as a heavy line in the half-section of Fig. 1.

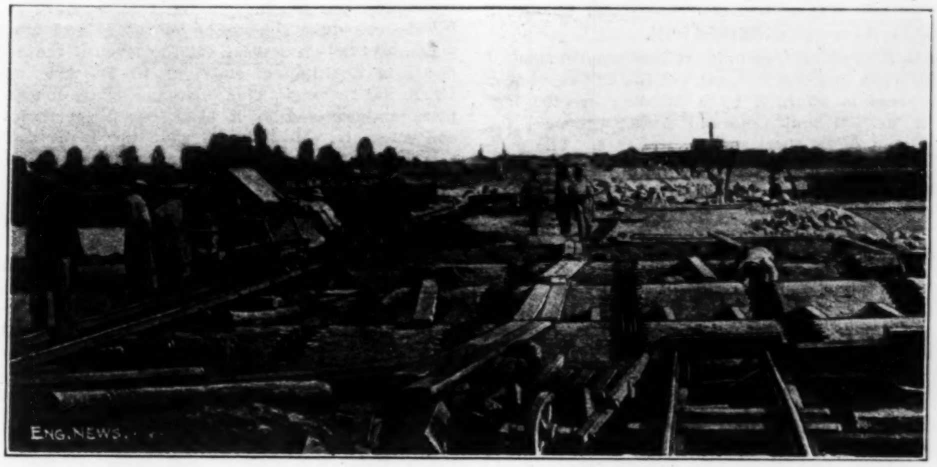
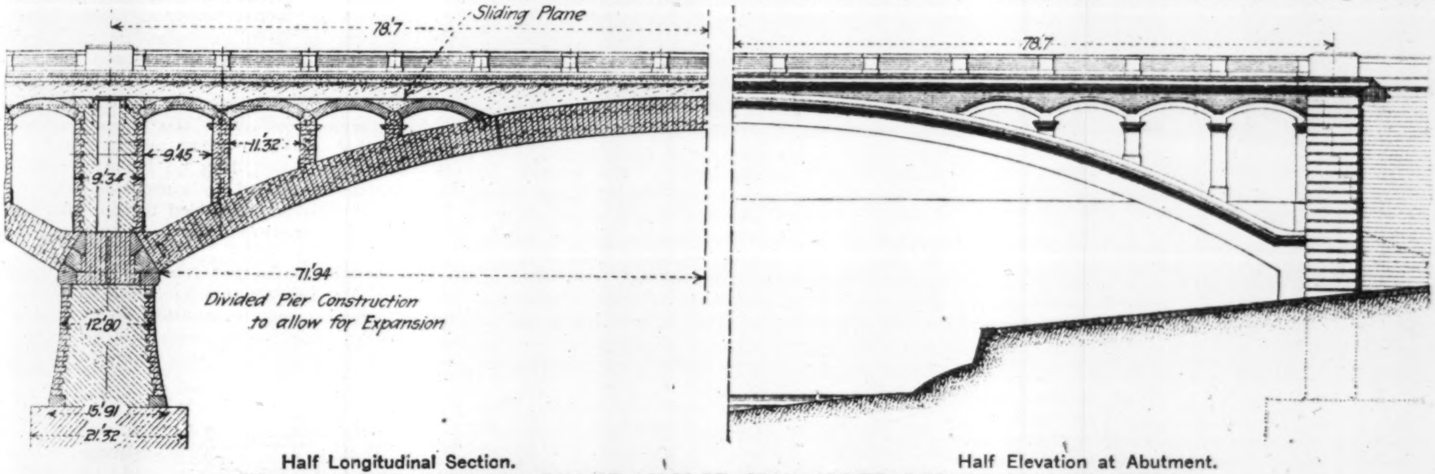


FIG. 3. VIEW FROM A PHOTOGRAPH, SHOWING THE POSITION OF CONCRETE STEEL TIES IN MASONRY SPANDREL ARCH CONSTRUCTION.

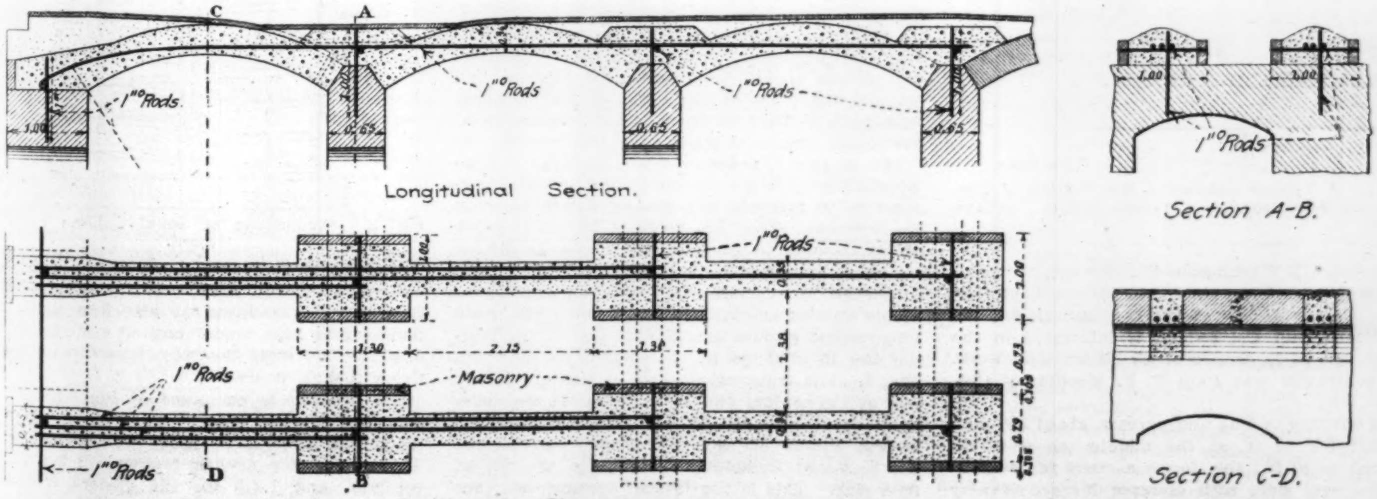
(Rods shown in place just prior to the placing of the concrete.)

The bridge, which was finished during the sum-



Half Longitudinal Section. Half Elevation at Abutment.

FIG. 1. A FLAT MASONRY ARCH OF 143.88-FT. SPAN, 19.0-FT. RISE, AT ORLEANS, FRANCE.



Longitudinal Section. Section A-B. Sectional Plan. Section C-D.

FIG. 2. VERTICAL SECTION AND PART PLAN, SHOWING POSITION OF IRON RODS IN SPANDREL ARCHES, ORLEANS, FRANCE.

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*Data obtained from "Le Genie Civil," Sept. 20, 1906.

†Engineering News, May 18, 1893.

mer of 1906, was designed and constructed under the direction of M. Renardier, Chief Engineer of the Ponts et Chaussées, with MM. Levesque, Legay and Yèvre as his assistants. The contractors were MM. Dedeyn and Perchot. The total cost of the bridge proper was about $470,000.

A CHICAGO WAREHOUSE OF REINFORCED CONCRETE CONSTRUCTION.

An interesting example of the application of reinforced concrete construction to warehouse buildings is afforded by a building erected last year at 43d and Colorado Aves., Chicago, for Weyman & Brother, snuff merchants. The general design and all structural details were worked out by the firm of Richard E. Schmidt, Garden & Martin, 172 Washington St., Chicago, to whom we are indebted for plans and information. Mr. J. C. Thom, of New York, is engineer for the American Snuff Co. (which is interested in the plant), and is in charge of all its building work. The contractor was Paul F. P. Mueller, of Chicago.

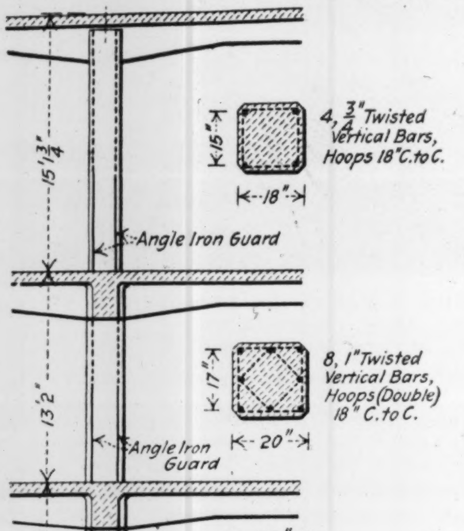
4, ¾" Twisted Vertical Bars, Hoops 18" C. to C.
15"
18"
15'1¾"
Angle Iron Guard
8, 1" Twisted Vertical Bars, Hoops (Double) 18" C. to C.
17"
20"
13'2"
Angle Iron Guard
23"
20"
8, 1" Twisted Vertical Bars, ¼" ○ Spiral 1½" Pitch
Spiral
13'2"
Angle Iron Guard
2'1"
22"
8, 1" Twisted Vertical Bars, ⅜" ○ Spiral 1¾" Pitch
13'2"
Continuous
Angle Iron Guard
24"
2'3"
8, 1" Twisted Vertical Bars, ⅜" ○ Spiral 1½" Pitch
13'2"
Angle Iron Guard
28"
Concrete Pier
Eng. News.

Fig. 1. A Typical Column in the Reinforced Concrete Warehouse of Weyman & Bro., Chicago, Ill.

Richard E. Schmidt, Garden & Martin, Architects.

The building is long and narrow, about 355 × 65 ft., but for 60 ft. at the middle the width is reduced to 40 ft.; this forms a court for wagons on the west side, with annexes for an elevator and stairway. There are four stories and a basement. Owing to the character of the soil found close to the surface of the ground the foundations are of concrete piers 4½-ft. diameter, formed by filling in cylindrical wells sunk about 8 ft. below the basement floor to a hardpan formation; the bottoms of the piers are enlarged by conical footings 4 ft. high to a base diameter of 9 ft., the load on the hardpan being limited to 10,000 lbs. per sq. ft. On the east side are two towers or wings containing elevators and stairways, and between these (at the level of the first floor) is a shipping platform 14 ft. wide and about 200 ft. long. This is supported by concrete piers and covered by a 14-ft. cantilever roof of concrete. It will be seen that the main floors are not broken up by elevator or stairway openings, all these being in towers or wings. The floors are designed for loads of 350 lbs. per sq. ft.; and the main and cantilever roofs for 25 lbs. per sq. ft.

In the main portions of the building there are two rows of interior columns, spaced 16 ft. c. to c. longitudinally, and forming a central bay of 20 ft., flanked on each side by one of 21 ft. 9 ins. At the middle of the building, however, there are three longitudinal spans of 20 ft., instead of 16 ft., and here the width is reduced so that the middle bay of 20 ft. becomes a side bay of 15 ft., the second row of interior columns being omitted.

The steel bars used in the reinforcement are the Ransome type of twisted bars. This type was selected by the architects for the reason that it can be obtained in steel having an elastic limit of not less than 60,000 lbs. and also sufficiently ductile to withstand without injury the bending required in adapting it for reinforcing purposes; the bars can also be obtained in the Chicago market at a price only slightly in excess of that of plain bars.

The columns are octagonal in section to the third floor, and then rectangular to the roof. The column reinforcement, shown in Figs. 1 and 2, is somewhat novel, the principal feature being the mechanical details of the spiral hooping used in the lower stories, as referred to below. There are eight vertical 1-in. twisted bars to the level of the fourth floor, above which there are four similar ¾-in. bars. These are spliced with wrought-iron pipe sleeves 6 ins. above the floor line. In the third and fourth stories these bars are hooped by double and single rectangular hoops of No. 8 wire, 18 ins. apart. The manner in which the double rectangular hoops in the third story are arranged to stiffen each other against bulging of the flat sides appears in Fig. 1. In the three lower stories, however, the bars are hooped by a continuous spiral coil of ⅜-in. wire (¼-in. in the second story), having a pitch of 1½ and 1¾ ins.; the pitch of the coil is maintained by vertical crimped wires placed on the outside and secured to vertical steel strips on the inside by clamps and set-screws (Fig. 2). With this arrangement, the coil reinforcement for a column can be built up complete in the shops and dropped directly into place in the forms. This column was designed by the American Wire Fence Co., of Chicago, especially for this building, in order to meet the architects' requirements: 1, That the spiral should be maintained absolutely cylindrical in form; 2, That some mechanical means should be secured for holding and spacing the pitch of the spiral to the distances specified; 3, That at least 1% of vertical reinforcement should be provided in the column.

The girders are designed and built as continuous girders, the foundations being of such character as to preclude any chance of settlement in the columns. They are made of increased depth at the columns in order to give ample dimensions to resist compression (which is in the bottom of the girder at these points) and to provide for ample reinforcement against shear. The main longitudinal girders are 16 × 25 ins. at the middle and 16 × 30 ins. at the column, as shown in Fig. 3. The transverse beams or ribs are 16 × 19 ins. at the middle and 16 × 25 ins. at the ends; these ribs are spaced 8 ft. apart, there being one in the middle of each main floor panel. The depth stated includes in all cases the 6½-in. floor-slab. This is the typical arrangement, but at the middle of the building, where the floor panels are larger, as already described, there are two intermediate ribs in each 20-ft. span, the ribs here being spaced 6 ft. 8 ins. c. to c. The steel reinforcement of the girders consists of longitudinal twisted bars and transverse stirrups of ⅜ × 2-in. iron, arranged as shown. Some of the bars are inclined so as to reach the top of the girder and extend across into the girder of the adjacent panel. The reinforcement for each girder is assembled on the ground, and set in place as one piece, thus materially facilitating the work as well as ensuring the proper spacing and arrangement of the bars, etc. Fig. 4 shows a portion of the assembled reinforcement for one of the main girders.

The floors are 6½ ins. thick, except that in the middle of the building where the panels are 6 ft. 8 ins. wide (as above noted) the thickness is 4½ ins. Of this thickness the odd half-inch is provided to take care of grooving and wear of the floor by trucking. The surface is finished with a very rich cement mortar. The floors are reinforced by a netting of No. 9 longitudinal wires about 3 ft. c. to c., crossed by ½-in. rods 8 ins. apart; other ½-in. rods, 5 ft. long, are laid across the tops of the girders (in the floor slabs) to take care of the transmission of shear from floor slab to rib when these parts are acting together as a T-shaped beam. The roof slab is 6 ins. thick, and has no ribs between the girders; for this reason its thickness is increased to 8 ins. in the larger panels at the center of the building. This thickness includes a ¾-in. finishing coat of 1 to 1 cement and sand to make the concrete watertight. The surface of the roof is also coated with tar composition. The roof girders between the columns are 16 × 14 ins. at the middle and 16 × 19 ins. at the ends. The slab reinforcement is similar to that of the floors, but has the ½-in. rods spaced 4½ and 5 ins. apart.

One of the special features of the general design is a cantilever roof over the shipping platform, which leaves the platform unobstructed by columns. This roof (Fig. 5) is supported by girders forming 14-ft. extensions of the girders of the first floor, and as in this case the compression is at the bottom of the girders instead of at the top (as in the floor girders) the 8-in. slab is formed level with the underside of the girders, thus making a flat ceiling. The 5-in. roof over the wagon dock on the other side of the building is carried by girders of 24-in. and 12-in. steel I-beams embedded in concrete, spanning the bay longitudinally between projecting wings of the building.

The exterior walls are of brick, but all lintels over the door and window openings are of reinforced concrete, built monolithic with the beams and floors. For the concrete stairway a very simple and economical design is employed, reinforced by twisted rods 4 ins. apart laid in the bottom of the 5-in. slab upon which the steps are formed. The landings are also 5-in slabs. The hand-railing is made entirely of light steel angles. The main doorways are fitted with the Cross folding doors.

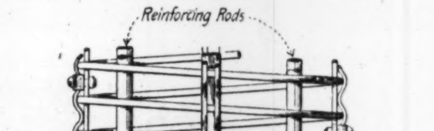

Fig. 2. Assemblage of Spiral Column Reinforcement.

The concrete is composed of Portland cement, sand and crushed gravel, mixed by machine and made wet enough to pour from wheelbarrows. The proportions are as follows: 1:2:4 for the columns, and 1:3:5 for the girders, floors and roof.

DECISION IN THE CAMERON SEPTIC TANK SUIT AGAINST SARATOGA SPRINGS, N. Y.*

The patent in suit, applied for March 15, 1897, and issued Oct. 3, 1899, to Donald Cameron, Frederick J. Commin and Arthur J. Martin, of Exeter, England, is for a process and apparatus for treating sewage. It declares that the patentees "have invented certain new and useful improvements in processes of and apparatus for liquefying and purifying sewage" for which they have received letters patent in England, No. 21,142, dated Nov. 8, 1895, and in other foreign countries, giving dates and numbers. It then declares that "the following is a full, clear, and exact description of the invention which will enable others skilled in the art to which it appertains to make and use the same." It also declares that the object of the invention is to provide an artificial method and apparatus for the liquefaction and purification of sewage on a practical and efficient scale in a natural and simple manner avoiding the formation of sludge. It also declares that the invention consists: (1), in certain methods of developing in a flowing current of sewage bacteria capable of dissolving the mass of solid organic matter contained in the sewage; (2), of subsequently utilizing the so-developed bacteria in liquefying the mass of organic matter contained in the flowing current of sewage; and (3), of further purifying the effluent liquid. The patent then declares that the invention also consists in the apparatus for carrying out the process. It further declares that "the process of purification comprises the subjection of the sewage to the dissolving action of anaerobic bacteria and subsequently to exposure to air and light."

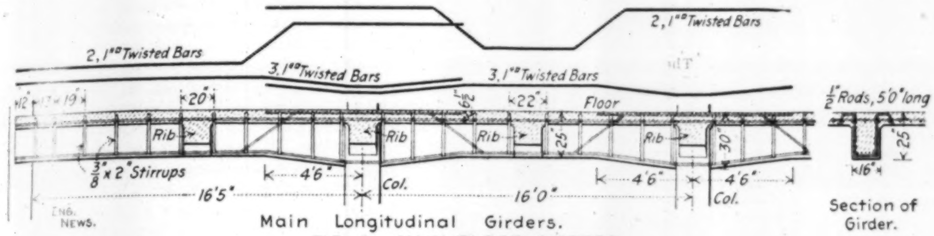

FIG. 3. MAIN FLOOR GIRDERS.

The patent then describes the process as follows:

> In carrying out the process the first step is to develop in a flowing current of sewage micro-organisms or bacteria of a character and quantity capable of practically liquefying the mass of solid organic matter contained in the flowing current of sewage. This is effected by forming a pool in the flowing current and secluding said pool from light, air and agitation, while permitting a non-disturbing inflow of the sewage into the pool and an outflow therefrom. In this condition of the pool in the absence of light, air, and agitation the micro-organisms increase at a fabulous rate, being fed by the incoming solid matter of the sewage until a mass of bacteria is developed sufficient in character and quantity to liquefy substantially all the solid organic matter contained in the sewage passing through the pool. During this operation there is formed on the surface of the sewage in the pool a brown scum. This crust of solid substances floating and completely bridging over the water is from 2 to 3 ins. thick, and although there is a continued inflow of raw sewage and a continued outflow of the liquid effluent this scum remains at about the same thickness and does not increase. This scum attains its thickness of from 2 to 3 ins. in about a week after the tank is put into use, and although no part of it is removed it continues at the same thickness. After the formation of this practical solid-dissolving mass of bacteria the non-disturbing inflow and outflow are continued until practically all the solid organic matter is dissolved and the outflow is in the form of a liquid without solid particles of sewage. The operation goes on and the flowing current of sewage is continually liquefied. The liquefied sewage as it leaves the septic pool has a slight odor, so slight, however, that it cannot be noticed at a distance of a yard or two, and to relieve it of this slight odor it is subjected to an aerating operation.

The patent then states that in some systems now employed where purification is sought, the crude sewage is first treated chemically, so that the solids are to a great extent precipitated and that it is only the liquid which is treated by filtration or otherwise. That in such processes the solid matter rapidly accumulates in the form of an offensive sludge which is difficult to dispose of. The patent then declares that by the process described therein such treatment may be entirely dispensed with and the expense of dealing with the precipitated matter obviated. The patent also states that in the prior systems it has been considered of advantage that there should be contact of the sewage matter with the air, but that in the invention of the patent and in treating sewage under its process it is of the utmost importance that means be provided for preventing contact with the air and that the chamber in which the bacteriological action takes place should be dark in order to assist the bacteria contained in the sewage to rapidly multiply, it being a well known fact that bacteria multiply rapidly in dark places. The patent says that the exclusion of light and air can be secured by a closed cover to the tank or vessel containing the sewage, which cover may be removed after several days, as after such closed tank has been in operation two or three days the brown scum begins to form at the top of the mass of sewage and eventually becomes 2 or 3 ins. thick and serves as an air tight cover to the sewage underneath. The patent also states that this scum is formed by bacteriological action and rises in particles from the bottom of the tank, gas forming in and carrying the particles to the top of the mass. The patent also states that, after the tank has been in operation sufficiently long for this scum to commence forming, the effluent is so free from matter in suspension that it, the effluent, is in a condition to be further treated by any other means, such, for example, as coke-breeze filters, or for irrigation or for discharging into rivers or tidal waters.

Says the patent, "by this invention crude sewage can be treated for long periods without practically any sludge at all forming in the tank."

The claims for this process in suit read as follows:

> (1) The process of purifying sewage which consists in subjecting the sewage under exclusion of air, of light and of agitation to the action of anaerobic bacteria until the whole mass of solid organic matter contained therein becomes liquefied, and then subjecting the liquid effluent to air and light.

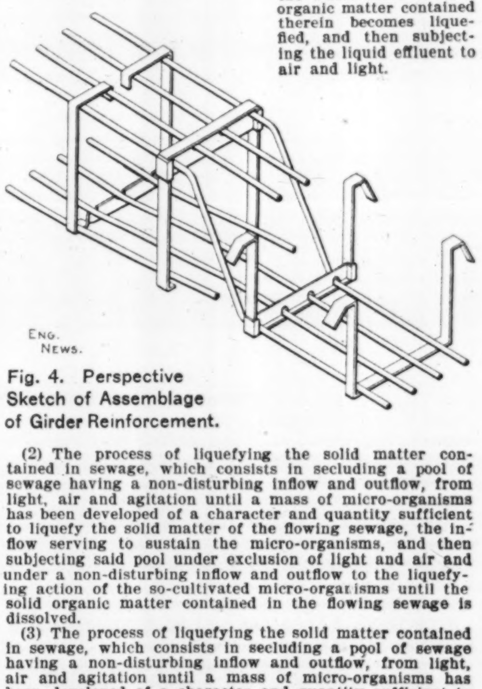

Fig. 4. Perspective Sketch of Assemblage of Girder Reinforcement.

> (2) The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow, from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, and then subjecting said pool under exclusion of light and air and under a non-disturbing inflow and outflow to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved.
>
> (3) The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow, from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, then subjecting said pool under a non-disturbing inflow and outflow and under exclusion of light and air to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved, and then subjecting the liquid outflow to an aerating operation.
>
> (4) The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, then subjecting said pool under a non-disturbing inflow and outflow and under exclusion of light and air to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved, then subjecting the liquid outflow to an aerating operation, and then to a filtering operation.
>
> (21) The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow from light, air and agitation until a thick scum is formed on the surface thereof and a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, and then subjecting said pool under the cover of said scum and under a non-disturbing inflow and outflow to the liquefying action of the so-cultivated micro-organisms until the solid matter contained in the flowing sewage is dissolved.

Claim one has two steps in the process: (1) subjecting the sewage, excluded from light, air and agitation, to the action of anaerobic bacteria until the whole mass of solid organic matter contained therein becomes liquefied; and (2) then subjecting such liquid effluent to air and light.

Claim two: (1) secludes in a pool the sewage from light, air and agitation until the micro-organisms have been developed to a sufficient extent to liquefy the mass; and (2) then subjecting the pool of sewage to the liquefying action of such micro-organisms, light and air being excluded, and the inflow and outflow of sewage being non-disturbing.

Claim three differs from claim two in that it adds the aerating operation, viz.: "and then subjecting the liquid outflow to an aerating operation."

Claim four differs from claim three in that it adds "a filtering operation" after the aerating operation.

Claim 21 adds to claim two the scum, before mentioned, as a means for covering the mass of sewage, after the micro-organisms have been developed, and protecting it or secluding it from light and air.

After this scum has been formed, air and some light may be admitted into the tank, containing the mass of sewage, above the scum, as then the scum protects the sewage and the micro-organisms therefrom. The anaerobes are bred, produced, and live and rapidly multiply in the sewage when secluded from light and air and the mass is free from agitation, and they feed upon and dissolve, or liquefy, so to speak, the incoming sewage. They die if exposed to light and air, and will neither multiply nor do their work effectually if the mass is agitated. When the mass has become liquefied, or as rapidly as it becomes liquefied, it flows out of the pool and tank, at the places provided in the tank, and is then, by exposure to the air, aerated and may then pass into a filter where it is subjected to the action of aerobic bacteria and other treatment and further purified.

It must be conceded that if this process was new and is operative it discloses utility and possibly patentable invention, if accompanied by suitable means. The patent assumes a practically continuously flowing current of sewage and it is obvious that if the process is to be made of use to mankind means for carrying it into effect must be provided. There must be a tank or receptacle in which the "pool" of sewage, except the water and fluids, may stand or remain while the "anaerobic bacteria" or "micro-organisms" are being developed, or grown, and during this period such tank must be substantially air tight, except as air is brought in with the sewage, and closed against light. Hence such a tank or receptacle must be provided. This must be connected with the sewage pipes so as to permit the inflow of sewage, but in such a manner and by such means as will prevent undue agitation of the pool of sewage therefrom, So there must be means provided for the egress or outflow of the liquefied contents or sewage and these must be so arranged as to prevent undue or serious agitation of the mass of sewage in the tank or the outflow of floating solids or the obstruction of the openings by such solids, or the breaking up of the "scum." Inside the tank proper the essential conditions are: absence of light, absence of oxygen, absence of agitation of the contents. But absence of air and of some degree of light in the tank above the mass of sewage is not essential after the formation of the "scum." These conditions being provided for and present in the tank, the process of liquefaction is self-acting; that is, the anaerobic bacteria or micro-organisms rapidly develop in the sewage itself and multiply and in due time liquefy the solids of the sewage which remain motionless in the bottom of the tank until liquefied by the action of the anaerobes. If agitation is avoided, the scum forms and covers the pool or mass of sewage in the tank, excluding light and air, and hence the process goes on uninterruptedly and all solids susceptible to such anaerobic action are liquefied and then pass out at the outlet of the tank. As this liq-

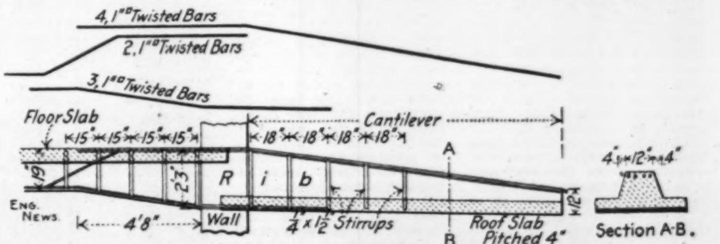

FIG. 5. CANTILEVER ROOF OVER SHIPPING PLATFORM.

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*Opinion by Judge Ray, U. S. Circuit Court, Northern District of New York, in Cameron Septic Tank Co. (of Chicago) vs. Village of Saratoga Springs. Suit in equity to restrain alleged infringement and for an accounting. Gifford & Bull, etc., for complainants. John J. Healey, Jr. (Saratoga Springs and 32 Liberty St., New York City), etc., for defendants. [We are informed that the company will appeal.—Ed.]

uid outflow has some odor it is wise but not absolutely essential to subject it to further processes of purification before permitting it to go at large. Hence means for "aerating" and, if desirable, means for the "filtering operation." But these two processes are old, independent of each other and also independent of the liquefying processes carried on in the septic tank itself. The completed purification consists therefore of three successive processes: (1) liquefication by anaerobic action in the tank; (2) aeration in the aerator after leaving the tank; and (3) filtration after leaving the aerator. This is a mere aggregation of processes, two of which are old, while the other is a process of nature or a natural process performed by nature on a pool of sewage held in a tank under proper conditions long enough for nature to do its work.

The patent contains the following claims, in suit, for the "apparatus:"

(5) In an apparatus for the purification of sewage, the combination of a septic tank having an outlet disposed above the bottom and below the normal water-level of the tank, and open across the greater part of the width thereof, and an aerator connected with said outlet.

(6) In an apparatus for purifying sewage, the combination of a drain or sewer, a settling-tank, connected therewith and adapted to receive the contents thereof, a septic tank connected with said settling-tank and provided with an outlet disposed above the bottom and below the normal water-level of the tank and open across the greater part of the width thereof.

(7) In an apparatus for the purification of sewage, the combination of a septic tank, and an outlet therefor disposed above the bottom and below the normal water-level thereof, said outlet comprising a conduit having a longitudinal slot open across the greater part of the width of the tank.

(8) In an apparatus for the purification of sewage, the combination of a septic tank having an outlet consisting of a pipe extending across the greater part of the width of the tank and disposed above the bottom and below the normal water-level thereof, said pipe having an opening in its wall throughout its length for admitting the effluent.

* * * * * * *

(11) In an apparatus for purifying sewage, the combination of a septic tank, an inlet disposed above the bottom of the tank and below the normal water-level thereof and occupying the greater part of the width of said tank, and an outlet extending across the greater part of the width of the tank and disposed above the bottom of the tank and below the normal water level thereof.

(12) In an apparatus for purifying sewage, the combination of a septic tank, an inlet occupying the greater part of the width of said tank, and an outlet extending across the greater part of the width of the tank and disposed above the bottom of the tank and below the normal water-level thereof, said outlet comprising a pipe having a longitudinal slot therein extending the greater part of its length.

* * * * * * *

(20) In an apparatus for the purification of sewage, the combination of a septic tank, means for excluding air and light, a non-disturbing inlet for said tank disposed below the normal water-level thereof and provided with a broadened mouth, a non-disturbing outlet for said tank disposed below the normal water-level thereof and provided with a broadened mouth, and a sewage-conduit connected with said inlet.

* * * * * * *

(22) In an apparatus for the purification of sewage, the combination of a septic tank, means for excluding air and light, a non-disturbing inlet for said tank disposed below the normal water-level thereof, a non-disturbing outlet for said tank disposed below the normal water-level thereof, and a sewage-conduit connected with said inlet.

After describing the drawings, the patent says:

Figs. 1, 2 and 3 represent a suitable tank for carrying out our invention, A being the tank, which is constructed of any suitable material, such as cement-concrete. It is shallow in comparison with its other dimensions and is provided with a cover 60, which is preferably made air-tight, and a man hole or holes 61 are provided in such cover and also made air-tight. An opening with a check-valve 62 (see Fig. 2) may be placed in the cover 60 of the tank A to permit of the egress of gases of decomposition. It is not absolutely necessary for the tank to have an air-tight cover, as above described, because the dark scum which forms serves to keep both light and air from the sewage; but we consider it important to provide the cover. The inlet 63 to the tank discharges into same some distance below the normal water-level and is preferably directed horizontally, or downward, as shown, so as to avoid breaking the scum which forms in the tank when sewage has been in it for two or three days.

The outlet from the tank is submerged, preferably in the upper half of the depth of the tank, and is extended across the whole or the greater part of the width of the tank, so as to draw off the clear water below the scum or floating matter without disturbing the latter. It is necessary to discharge the contents of the tank or vessel along an extended line lest the flow should be concentrated to a point or points of discharge and so disturb and carry away the floating matter. The outlet therefore, consists of a pipe or conduit 10, which may or may not be closed at its top, following the line along which it is desired that the contents of the vessel or tank A should be discharged and having throughout its length of a part thereof a slot or aperture by which liquid may enter the said pipe or conduit. Such slots or apertures may diminish in size toward the outlet or outlets from the said pipe or conduit, so as to avoid an excessive rate of flow thereinto near such outlet or outlets, thus maintaining a uniform flow into such pipe or conduit throughout its length. The slots or apertures may be placed in any position along said pipe or conduit 10, so as to admit liquid into the same in a downward, upward, horizontal, or oblique direction, as may be desired.

If desired or found advisable, the slots or apertures may be protected by a deflecting surface or surfaces so placed as to ward off solids or liquids coming from any particular direction. The slot or apertures may also be provided with a strainer for the exclusion of solid matter.

The pipe or conduit 10 may be fixed or movable.

The size of the tank will depend upon the quantity and character of the sewage to be treated. Preferably two or more tanks should be provided, so that any of them may be emptied, if necessary, without interrupting the purification of the sewage.

* * * * * * *

In the arrangement shown in Figs. 1, 2 and 3 the sewage or other liquid coming through the sewer 13 is delivered into a well, 14, where grit and other solid matters are allowed to settle. It then passes through the pipes 15 and 16 and the inlets 63 into the tank A, in which it may be treated either chemically, bacteriologically, or otherwise, as desired; but it is preferable to treat it bacteriologically. After treatment in the tank A it passes into the pipe or conduit 10 through the slots or apertures provided for the purpose, the effect of which is that it is evenly delivered all along the line of the opening or openings into the pipe or conduit and concentration of the flow to one or more points is avoided. From the pipe or conduit 10 the effluent passes through pipes 17 (which may, if desired, be provided with suitable valves) into the aerator 18, which, as shown, is divided into a suitable number of compartments 64. The effluent passes into the first of these compartments, and when this is filled it passes out through an opening at the top into a slightly-sloping surface 65, down which it flows in thin films until it falls into the next compartment 64, this operation being repeated until it arrives at the last compartment, whence it may, if desired, be conveyed through pipe 66 to a filter or filters for further treatment. It will be seen that as the effluent passes over the inclined surface 65 it will be exposed to the action of the air and so aerated. Instead of employing the form of aerator above described an overhanging lip or lips may be provided, over which the effluent falls in a thin film or films exposed on both sides to the air.

Claim 5 has in combination the "septic tank" having "an outlet" a, "disposed above the bottom and below the normal water-level of the tank," and, b, "open across the greater part of the width thereof," and, 2, "an aerator connected with said outlet." No sewer or connection of the tank therewith is mentioned.

Claim 6 adds a drain or sewer, a settling tank (which is outside the septic tank and connected therewith).

Claim 7 is the same as claim 5, without the aerator, but with the addition of a conduit, forming a part of the outlet, "having a longitudinal slot open across the greater part of the width of the tank."

Claim 8 has in combination the septic tank and "an outlet" described in the claim, "consisting of a pipe extending across the greater part of the width of the tank and disposed above the bottom and below the normal water-level thereof, said pipe having an opening in its wall throughout its length for admitting the effluent."

Claim 11 has (1) the septic tank; (2) "an inlet disposed above the bottom of the tank and below the normal water-level thereof and occupying the greater part of the width of said tank;" and (3) the outlet not having the pipe of claim 8.

Claim 12 has the tank and the inlet, but its location is not given, and also the outlet with pipe.

Claim 20 has (1) the septic tank; (2) means for excluding air and light; (3) a "non-disturbing inlet" for the tank disposed below the normal water-level thereof and provided with a broadened mouth; (4) a "non-disturbing outlet" for said tank disposed below the normal water-level and provided with a broadened mouth; and (5) a sewage-conduit connected with such inlet.

Claim 22 is the same as claim 20 except that the "non-disturbing" inlets and outlets are not "provided with a broadened mouth."

Some of these means, in combination, if new and operative, would seem to disclose patentable invention. Such a tank as is described (tank pure and simple) in its mere construction and shape and size, whether covered or not, is not new or novel. It neither performs any new or novel function nor permits or causes any new or novel function to be performed within it. As a closed tank, pure and simple, it holds the sewage placed therein by force of gravity or otherwise, and being darkened and made (in the beginning of the process) air tight it permits and enables one of the processes of nature to go on therein. Such always has been and such always will be the function of such a tank. That the process described goes on therein may have been a new discovery, but the process of nature is not caused by the tank. The outlet "disposed above the bottom and below the normal water level of the tank and open across the greater part of the width thereof" is not new. So of "an aerator" connected with the outlet. The tank is to hold and contain the pool or mass of sewage; the outlet is for the escape of the fluid after nature has done its work, and the aerator is to expose the fluid after escape from the tank to the action of the air. The outlet is necessary a part of the tank if it be made operative, an aperture or apertures or opening or openings into it. There is no new office or function performed by the tank. It receives and holds sewage as it always has received and held sewage or other and similar matter. It merely permits the operations or processes of nature which take place under the conditions found there to go on uninterruptedly. Being in a dark place with oxygen excluded and free from agitation the micro-organisms, or anaerobic bacteria, are produced and multiplied by the sewage itself and fed by the fresh sewage constantly coming in. The opening or outlet with broadened mouth and extending as stated is not peculiar or new nor does it perform any new office or function. It permits the outflow of the fluids when they have so accumulated in the tank that the laws of nature force and draw them out. But it may be so arranged as to be "non-disturbing." This seems to be done by its location below the surface of the sewage and by the width of the discharging opening or mouth. The aerator is attached or connected therewith, but not in any new or novel manner and it performs no new or novel function. It operates in the old way to produce the old result by, so to speak, separating the noxious gases or effluvia from the fluid. It permits and hastens their escape. It forces air or carbonic-acid gas into the outflowing liquid. It has nothing whatever to do with what is going on inside the tank. Its operation is a distinct one and the only connection it has with the one done in the tank is that it is performed on the same fluid produced in and which has come from the tank.

I cannot see anything new or novel in the combination of claim 5 unless it resides in the "septic tank." But what is the "septic tank" of the patent? Is it any new or novel tank? Are not all tanks and receptacles, which permit the ingress and egress of flowing material and the formation of a pool of such material therein and the retention of such pool secluded from light and air and agitation until the anaerobic bacteria have sufficiently developed to convert the solids into fluids, septic tanks in the sense of the patent? It seems to me clearly so. Hence the "septic tank" of the patent to be different from any other water, air and light tight tank must have connected therewith and forming a part thereof means, or structures, openings and connections, which permit the reception, retention and repose of such material under the conditions named until the bacteriological action has taken place and been completed and then permit the outflow of the resultant fluid. I think that in the patent in suit the patentees in the use of the words "septic tank" meant any tank or receptacle capable of being provided with inlets and outlets and of being made air tight and so constructed as to exclude light, and which when provided with proper inlets and outlets so as to prevent undue agitation of the contents and when so constructed as to be air tight and dark, would permit the bacteriological process to go on to completion, and that, therefore, as applied to the tank proper, it has no special significance. They did not refer to the completed tank, one provided with inlets and outlets and a cover, for these are described as elements separate and distinct from and not as constituent parts of the "septic tank." They did not refer to a tank in which putrefaction might or necessarily would take place, but to one which when properly equipped would produce and permit this anaerobic action. As so construed claim 5 is invalid, as it does not disclose patentable invention. Such or similar tanks were old in the prior art. If the claim is valid every tank having an outlet disposed above the bottom and below the normal water-level of the tank and open across

Fig. 1.

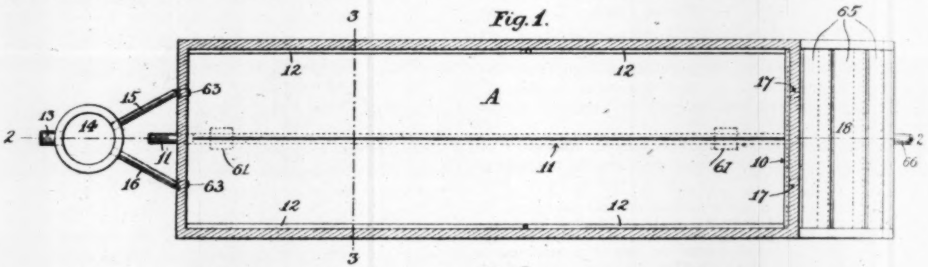


Fig. 2.

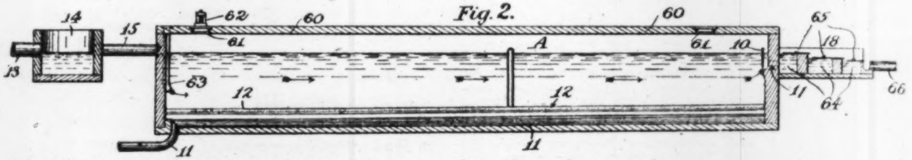
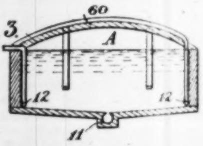


Fig. 3.



the greater part of the width thereof is monopolized if an aerator is connected to such outlet. As such tanks with such outlets were old in this art and the aerator, also old, has nothing to do with its operation but simply receives the fluid for the purpose of aerating it by an operation or process of its own, I do not see patentable invention in the combination. We have a mere aggregation of old devices, or old elements each performing its old office or function in the old way.

Claims 6, 7, 8, 11 and 12 are void for the same reason. Neither of them discloses anything new or novel. The settling tank of claim 6 is entirely outside of the main tank, is old in the art and performs no new office or function, and has nothing whatever to do with the processes of liquefaction, aeration or filtration.

But in claims 20 and 22 we have a different proposition. Here we have in combination (1) a septic tank, (2) means for excluding air and light, (3) a non-disturbing inlet for said tank, (4) a non-disturbing outlet for said tank, and (5) a sewage conduit connected with said inlet. Here we have an operative and useful apparatus provided with a "non-disturbing" inlet and a non-disturbing outlet, and unless these are found in the prior art the claims may be valid. But it is contended that they are found in the prior art. But, first, what is the "non-disturbing inlet," and what is the "non-disturbing outlet" of the patent in suit? This non-disturbance relates to the scum and its protection and not to the non-agitation of the mass of sewage forming the pool, also to the retention of floating matter. Says the specifications:

> The inlet 63 to the tank discharges into same some distance below the normal water-level and is preferably directed horizontally, or downward, as shown, so as to avoid breaking the scum which forms in the tank when sewage has been in it for two or three days.
>
> The outlet from the tank is submerged, preferably in the upper half of the depth of the tank, and is extended across the whole or the greater part of the width of the tank, so as to draw off the clear water below the scum or floating matter without disturbing the latter. It is necessary to discharge the contents of the tank or vessel along an extended line lest the flow should be concentrated to a point or points of discharge and so disturb and carry away the floating matter.

There is no reference to any non-disturbance of the mass of the pool in which the bacteriological action or process is taking place or being performed. Then follows a description of the outlet, viz.:

> The outlet therefore consists of a pipe or conduit 10, which may or may not be closed at its top, following the line along which it is desired that the contents of the vessel or tank A should be discharged and having throughout its length or a part thereof a slot or aperture by which liquid may enter the said pipe or conduit. Such slots or apertures may diminish in size toward the outlet or outlets from the said pipe or conduit, so as to avoid an excessive rate of flow thereinto near such outlet or outlets, thus maintaining a uniform flow into such pipe or conduit throughout its length. The slots or apertures may be placed in any position along said pipe or conduit 10, so as to admit liquid into the same in a downward, upward, horizontal, or oblique direction, as may be desired.

The patent also says these slots or apertures in the pipe or conduit described may be protected to ward off solids or liquids coming from any particular direction or provided with a strainer for the exclusion of solid matter. Such devices are old in this art.

The inlet 63 before described in connection with Figs. 1, 2 and 3 is described in claim 11, which is in suit, as "disposed above the bottom of the tank and below the water-level thereof" and as "occupying the greater part of the width of said tank." I do not find any special form of construction mentioned. This then is the "non-disturbing inlet." Turning to the prior art for tanks and inlets and outlets thereto we find in the

PRIOR ART

the French patent to Mouras No. 144,904, of Sept. 22, 1881 (to which we shall recur in discussing the process), describing his "automatic and odorless scavenger" in which he provides for: (1) "An air tight tank, hermetically closed, of a capacity in proportion to the needs it is to satisfy. (2) A feed pipe B, sealed to the top of the tank and destined to receive evacuations, slops and rain water." Here we have the tank of the patent and the sewer pipe connected therewith (at a different point, however) discharging the sewage into the tank. (3) "An elbow pipe C, likewise fastened to the upper part of the tank and serving to discharge the sewage contained in the tank." Here we have the outlet of the patent in suit. However, the inlet does not "occupy the greater part of the width of such tank" nor does the outlet extend "across the greater part of the width of the tank." Neither does this outlet comprise "a pipe having a longitudinal slot therein extending the greater part of its length." Mouras continues, "The feed pipe B" (sewer pipe) "as well as the discharge pipe C, both well sealed, are to plunge" (extend) "from 10 to 15 cm. into the liquid in the tank." Hence practically and in effect they are "disposed above the bottom of the tank and below the normal water-level thereof." But as stated, this discharge pipe or outlet does not comprise a pipe having a longitudinal slot therein extending the greater part of its length. It is the ordinary pipe. There is greater disturbance of the contents of the tank both at the point of ingress and at the outlet, consequent upon the centralization of both inflow and outflow. Mouras says his tank may be constructed in all kinds of forms and of all kinds of materials, but the "first condition to fulfil is to have it perfectly air tight." Another condition is that "the receiving pipe and the discharge pipe each at its lowest end plunge into the liquid in the tank to a depth of 10 to 15 cm., for it is this covering of water which prevents the entrance of outer air into the tank." Further on he mentions a further advantage of having the discharge pipe submerged, in that it will prevent the escape of floating substances. Evidently Mouras had no conception of the utility of or necessity for non-agitation of the contents of the tank. He makes no mention of the "scum" or of any equivalent or of its preservation unbroken. However, his location of the ends of the pipes will, to an extent, prevent disturbance of the scum and of the underlying contents of the tank.

In May, 1883, one Philbrick gave to the scientific world through the "Sanitary Engineer" a valuable article on "The disposal of sewage by subsurface irrigation in suburban residences." He described three connected tanks, one, the "settling basin," receiving the sewage through a pipe or inlet discharging below the surface of the sewage and discharging it when liquefied through pipes or outlets opening and receiving the outflow below the surface "so that the overflow of the settling tank may not be from the surface or scum, nor from the bottom, but from a point about a foot below the surface." Here the outlet was through several pipes arranged horizontally. In the English patent to Lake, No. 5391, June, 1882, "Improvements in and relating to Cess-Pools," we have both the supply pipe and the discharge pipe described and claimed as discharging the sewage and receiving the fluid, respectively, below the surface of the contents of the receptacle or tank. In the U. S. patent to F. L. Union, No. 424,838, April 1, 1890, we have a cesspool with sewer pipe discharging into the pool below the surface of the contents and the discharge pipe taking up the fluids much lower down.

In the English patent to Thomas Walker and another, No. 2329, September, 1864, for "Apparatus for Utilizing Sewage," etc., we have two tanks, one called "a trough" and the other the "settling pit or reservoir." They are separated by a wall. The "conduit" or sewer pipe extends along the entire end wall of "the trough" on the outside thereof and is connected with it by many passages "at various distances of its length and these passages a'a' are below the surface of the sewage matter." The sewage passes from the said "conduit" through these passages into the first tank or "trough," where the solids are retained "and sink to the bottom thereof," but the fluid portion with the floating substances flows over the top of the wall forming the inner side of the trough (being the wall separating "the trough" from the "settling pit") but on their way to the settling pit or reservoir the lighter and floating substances are intercepted by a screen and a grating arranged for the purpose. The flowage from this "trough" to this reservoir is along the entire width of the latter. Here we have plainly pointed out and suggested every idea of means contained in either the "non-disturbing inlet" or the "non-disturbing outlet" of the patent in suit. True, as to the mere mechanical device at the outlet of the patent in suit there is the substitution of equivalents. But there is a change of form only, not of principle. We have a slow uniform outward and a slow uniform inward flow along the entire width of the reservoir and both are non-agitating or non-disturbing. The flow of sewage from the sewer pipe or conduit into the first tank, or "the trough," is underneath the surface of the sewage therein. The outflow from "the trough" to the "reservoir" is not, but it might be, if advisable for any purpose, and is plainly indicated in the prior art, as in the Walker patent itself, for there is no difference in principle between the flowage from the conduit or sewer pipe into the first tank or "trough" and the flowage from the trough into the second tank or "settling pit." Here we have the avoidance of currents and centralization of flowage and we have "the grating" and "the screen" to arrest all floating matter. In the Wigner, British, patent, No. 364, 1870, page 7 thereof, we have the mixture of chemicals and sewage carried from the mixing pit to the precipitating tanks through culverts extending the entire width of such tanks and numerous openings along said culverts from such culverts into the tanks, all below the surface of the sewage in such tanks and in which non-disturbance is essential, they being "precipitating tanks." In the U. S. patent to Meyer, No. 505,166, Sept. 19, 1893, we find inlets into the vats or tanks for the sewage, the "discharging ends" of which "are expanded laterally as shown in Fig. 1, so to spread the sewage and check its flow as it enters the settling vats." What is this but the "non-disturbing inlet" of the patent in suit. As shown in the Meyer patent, these discharging conduits or sewer pipes are expanded the entire width of the vats. These vats have "eduction conduits" along their entire width with numerous openings thereto which converge later and lead to the filter. These "openings c.c. from the vats into the eduction conduits C. C. are located below the level at which the liquid sewage is designed to be maintained so as to prevent any greasy scum or light refuse which may pass the partitions b2 from entering the filter," says the Meyer patent. In addition there is a baffle board described to regulate the flow of sewage.

In the Scott-Moncrieff U. S. patent, No. 530,622, Dec. 11, 1894, we have a non-disturbing inlet with broadened mouth, but the outlets, extending the entire width of the tank, are at the surface of the liquefied sewage.

The British patent to Gurtler, No. 7,134, 1887, shows a non-disturbing inlet and a non-disturbing outlet, each disposed below the normal water-level and each having a broadened mouth.

In the claims of complainant's patent in suit for apparatus I fail to find patentable invention in view of the prior art. There is no improvement in apparatus that would not occur to any mechanic skilled in the art. In fact the only improvement, if it be that, is in the addition to the outlet of the "pipe having a longitudinal slot therein extending the greater part of its length." This is a mere substitute device to aid in the even and non-disturbing escape of the outflowing liquid. It is a slotted pipe to take water slowly and evenly and even if new shows no new conception or idea of means amounting to invention. All the claims in suit for apparatus are invalid for want of invention, in view of the prior art. But even if valid they must be given a very narrow construction and limited to the very devices specified, as, for instance, "a pipe having a longitudinal slot therein extending the greater part of its length."

PRIOR ART IN PROCESS CLAIMS.

We will not consider the validity of the process claims. Cameron seems to have described extended discovery as to the actual workings or action of micro-organisms and anaerobic bacteria. Mouras discovered the result of their action in and upon sewage about forty years ago, some twenty years prior to his French patent. In December, 1881, an article on the subject, and regarding the Mouras patent, was published by M. F. Moigno in Weekly Review of Science and Industry. This was to be followed and was followed by another article in the same journal, written by Moigno, published to the world in January, 1882. These articles refer to and enthusiastically describe the Mouras discovery and invention and add discoveries and conclusions of their author, in which, after stating that he has seen and conversed with M. Mouras, among other things he says:

> To-day at last, all obstacles being removed, I can freely expose in all its details, the simplest, finest, greatest perhaps of the inventions of modern times. . . . The automatic scavenger is, in fact: 1st, hermetically closed, and closed by the most inviolable of fastenings, hydraulic fastening, that is to say, its contents is shut off from all contact with the surrounding atmosphere; for that very reason, 2d, it is absolutely odorless and renders all infection impossible" (note these are results but not the main purpose or necessity of making it air tight); 3d, by a mysterious operation and one which reveals a quite new principle, it transforms all it receives, solid and liquid excrements, in a rather short space of time and without the addition of chemical ingredients, into a homogeneous liquid, only slightly turbid, and holding everything in suspension in the form of scarcely visible filaments, without leaving any deposit on the sides of the evacuation pipe nor at the bottom of the drain pipe. . . . 5th, the liquid which escapes, while it contains all the organic and inorganic elements of the evacuations is almost odorless. . . . Are not these results truly marvelous, which leave absolutely nothing to be desired, which moreover go beyond all hopes and expectations.

He also points out that there is no sludge or refuse, nothing left to take from the tank, and also the necessity of having the inlet and outlet below the surface of the sewage. In short, the "sludge problem" is solved and the process of nature published to the world. In his article of Jan. 21, 1882, Moigno points out certain results and advantages, and then says:

> That is already marvelous, but what is still more marvelous is the fact that these great results are very nearly effects which cause or are produced almost from nothing by the simple material transformation of the ordinary barbarous cesspool, without appeal to any new agent, without the invention of chemical ingredients, or even without addition of water from other sources, by the sole fact that the transformed tank lends itself to the employment or better to the bringing into play of a force of nature wholly unforseen and unknown till the present time, mysterious as well as marvelous in its magic effects. Who would have suspected that animal evacuations naturally contain and carry with them the principle of fermentation or of dissolution necessary and sufficient to liquefy and render them immediately of use in their return to the soil which had furnished their element, not without impoverishing itself. . . . .
> air-tightness, impenetrability to liquids or air is the essential condition of the successful working of the scavenger, it becomes, also, before everything, odorless; . . .
>
> Thus filled with water and hermetically closed, the scavenger is ready to fulfill its functions truly marvelous and extremely effective. If a first liter of feces enters the tank, there will come out of it a liter of water which will be nothing but pure water; but after a certain time of operation, when the feces shall have entered in sufficient quantity, the liquid discharge will begin to be turbid and of a brownish color, not very dark. But however prolonged the workings of the scavenger may

> be, were they to last twenty years, however great the quantity of feces that may enter its bowels, on the sole condition that there shall have been allowed to penetrate at the same time the urine and in a certain proportion slops and rain water, there will never come out anything but the slightly turbid and colored liquid which is the only discharge from the hermetically closed tank. Why? Because there is going on in the heart of the scavenger a process of fermentation entirely unforeseen, which dissolved in a more or less brief space of time the most solid feces and divides foreign bodies into particles or fibers so thin that they can scarcely be seen floating in the turbid liquid, without the latter forming any deposit or at least any deposit that adheres to the sides of the vessels or pipe through which it flows.

He then goes to the reasons for this action, the causes, and says:

> 3d. Theory of secret of the scavenger.—Here comes up the great question: how are solid matters so unassailable by water, so insoluble in water, by the contact with water, dissolved and made liquid so surely and easily in the heart of the automatic scavenger? I do not yet know in a certain and rational way. . . . .
>
> Therefore, if I am not mistaken in the heart of the scavenger, the great agent of dissolution, of liquefaction would be hydrosulphate of ammonia or one of its congeners. Sheltered from contact with the air or oxygen its action would determine a kind of putrid fermentation, the last period of which would be the dissolution, the liquefaction of the solid feces, . . . May it not be discovered perhaps that the mysterious agents of fermentation, cause of the decomposition and liquefaction of the feces are the vibrions or anaerobic bacteria which, according to Pasteur, are destroyed by oxygen and which manifest their destructive activity only in vessels from which the air is excluded?

He then gives certain observations and experiments, and says, among other things:

> 1st. Only urine, feces and a very little water, hardly a glass a day, entered the aquarium; nevertheless the liquefaction was complete; the excrements are so dissolved that they no longer sink to the bottom, and everything remains in suspension in the liquid. Solid feces introduced the 29th of August were completely liquefied the 16th of September, with the exception of matter not digested by the stomach, stones and skins of grapes, the stony concretions of pears, etc. Onion and carrot pealings, cabbage leaves, etc., floated on the surface some time, then sank to the bottom to await their decomposition or dissolution; such is the case with all foreign substances that are soluble, and even with paper, which at first rises to the surface, becomes more and more saturated with water, sinks to the bottom and disappears as if melted away. . . . .
>
> The feces always rose to the surface, mixed together, forming a kind of slimy pulp, of a thickness which never exceeded 5 cm., in consequence of the constant dissolution of the lower layers. After there had been added ten liters of water, the undigested substances, such as vegetable refuse, were seen to arrange themselves on the surface, in the order of their density, then sink to the bottom of the tank to await their decomposition, which took place insensibly; it is a deposit not sedimentary but flaky, which little by little melts and dissolves to be soon discharged by the waters of the aquarium, which show to the glance no foreign substance in suspension.

He also points out that absence of air is absolutely essential, as follows:

> Hermetical is therefore the condition necessary, indispensable and sufficient of the dissolution of the liquefaction of the feces and of the wonderful working of the scavenger.

H has also discovered the "scum," for he says:

> The disaggregation or dilution of matter is complete after thirty days immersion in the tank, so that the feces never form on the surface of the water anything but a layer of 75 mm. thickness, which renders their decomposition very easy.

These quotations demonstrate that it was known more than twenty-five years ago that sewage discharged continuously into an air-tight tank through an inlet below the surface of the mass of sewage therein, such tank being provided with an outlet opening from below the surface of such mass, would wholly dissolve into liquids, that is, become liquefied, leaving no sludge or deposits, and that the liquid would be almost entirely odorless; that a scum limited in thickness would form on the top of the mass of sewage; that this liquefying process was self-acting in the absence of oxygen; and that the probable cause of this process of liquefaction was the action of "vibrions or anaerobic bacteria which, according to Pasteur, are destroyed by oxygen and which manifest their destructive activity only in vessels from which the air is excluded." No mention is made of the exclusion of light, but the operation was carried on in a dark tank, as light was necessarily excluded from the vessels employed by Mouras.

As early as 1878 the German Empire granted to Dr. Alexander Müller, of Berlin, a patent for "A process of disinfection, purification and utilization of putrescent waste liquid or liquid sewage, by the rational cultivation of fermenting leaven-like organisms." After pointing out and referring to prior methods and their failure or inefficiency, the patent says:

> Now whereas the former disinfecting methods had for their essential object to obviate as far as practicable any phenomena of putrefaction (corruption or decomposition) the process herein described, on the contrary aims at the methodical cultivation of those small "leaven-like" organisms to the viability of which modern science has traced the so-called "self-unmixing" processes, namely, acidification, fermentation, putrefaction, decay or the like, in accordance with the rules of physiology, with a view to bringing them in to requisition in the task of precipitating out the liquid waste-substances or bringing about their complete mineralization (i. e., reduction to simple inorganic compounds).

It thus appears that the idea or conception of producing and cultivating and housing these micro-organisms was not new or original with the patentees of the patent in suit.

In the English patent to Lake, 1881, No. 5,391 (Provisional Specifications), this same process of the patent in suit was used, although it does not explain the "whys and wherefores" of the action on the sewage in the tank or cesspool. It states

> but that which is so discharged from this cesspool is always liquid holding in solution a certain quantity of substances proceeding from the decomposition and disaggregation of the fecal and other matters which are at the bottom of the cesspool or receptacle. * * * * *
>
> With this system there is no necessity for the usual removal of the solid matters, the decomposition thereof goes on constantly and there can be no liberation of gas; all the liquid flows away with the decomposed substances held in suspension, through the discharge pipe, and through a channel connected therewith, into a pipe which leads into the sewer; this last-named pipe dips slightly below the lowest water-mark in the sewer so that the contents of the cesspool are at all times protected from the air until they are discharged into the water in the sewer.

In the British patent to Adeney and Parry, No. 3,312, applied for March 1, 1890, and granted Feb. 14, 1891, they provide for keeping "the liquor to be treated under suitable conditions for the rapid multiplication of micro-organisms." The patent states that the germs of these micro-organisms are generally in the liquid, but they may be specially bred and added to it. In several places the patent specifications provide for the breeding and rapid multiplication of these micro-organisms and describe the work they do. Some of the conditions are described. [The following paragraph appears to be an abstract or quotation, but is not so marked in our copy of the opinion.—Ed.]

Whether we are to cultivate aerobes or anaerobes for the purification of sewage, the conception and principle involved is precisely the same. Each colony has its work; the one in the presence of oxygen and light, the other in the absence of oxygen and light. To cultivate aerobes we have a tank open to light and air and introduce oxygen; to cultivate anaerobes we have air-tight tanks like Mouras, thereby excluding oxygen and constructed of such material as to exclude light. For anaerobes the less agitation the better. But after all, we provide the conditions for the development and growth of each. The conception is that if we desire their action we must have their presence, and if we would have their presence we must provide the conditions under which they generate and multiply.

In November, 1892, Scott-Moncrieff, of London, England, applied for and in December, 1894, obtained United States letters patent No. 530,622 for "Treatment of Sewage and Apparatus therefor." He says:

> My invention relates to certain improvements in the treatment of sewage and the apparatus therefor, and has for its object to purify sewage and discharge a clear and inoffensive effluent. This I effect by the action of microbes which liquefy and break up the organic matters in the sewage. Hitherto it has been believed that the beneficent action of these organisms in the purification of effete matter could only be carried out in the presence of oxygen, and with this end in view experiments have been carried out almost exclusively in the direction of downward filtration, the object being to secure the largest amount of oxygen available by atmospheric contact during the operation. One obvious objection to this process is the necessity for preliminary straining or deposition of the coarser particles of the sewage to prevent clogging the filter. This straining or deposition, as a matter of fact, amounts to nothing more nor less than depriving the organisms of the greater proportion of their food supply, leaving a mass of filth which never enters the filter and consequently is never broken up or nitrified, and so constitutes a nuisance in itself. I have discovered that the total solid matter in ordinary sewage can be dealt with as the actual food supply of the organisms if it is properly conveyed to them. All that is required for this purpose is to concentrate the sewage in a comparatively small space, and to have a constant movement occurring. When this is done, there is no need for the same amount of oxygen as has hitherto been believed to be necessary.
>
> It is also an essential part of the process that the enzymos of the saprophytic species which perform the work should be removed as soon as formed from that portion of the filter bed wherein it is believed that the production of micro-organisms is most active.
>
> The following among others are the organisms which it is the especial object of the apparatus to cultivate, namely: bacillus fluorescene liquefacions, bacillus subtilis, protean forms (particularly the proteus vulgaris), bacillus figurans, &c.
>
> According to my invention, no preliminary straining of the sewage is necessary, the apparatus being so arranged that the bacteria multiply and unceasingly perform their functions, any previous removal of organic matter from ordinary sewage being detrimental to their action.
>
> My invention comprises also special means for maintaining them healthy and vigorous. I also provide means for the further purification of the effluent obtained from the cultivation filtering bed. * * * * * * * * *
>
> My invention includes also means for insuring the most favorable condition in the filtering material for the development of the micro-organisms contained in sewage. Suitable inlet, outlet, flushing, and cleaning appliances are provided, and my invention includes also special means of resting and aerating the filtering material without interfering with the continuity of the treatment.

He then describes his apparatus, and then says:

> This combined concentration and movement provides the conditions favorable to the development of micro-organisms which increase directly as the food supply, and continually encroach upon the same.
>
> Sludge or deposit (which merely represents that portion of the organic matter which the organisms have not had time to liquefy), and inorganic detritus, may be removed from the concentrating compartment when required by simply opening the penstock H at raking out or flushing. In order to maintain the conditions most favorable to the process in low temperature, I combine with the above described apparatus an arrangement of pipes PP as shown in Figs. 4, 5, and 6, for the circulation of hot water from a boiler P' whereby the filtering material M may be maintained when necessary or advisable at the temperature most favorable to the growth and action of the micro-organisms. * * *
>
> By making the concentrating conduit B of less capacity or contracted as compared with the filter bed of larger area above it, and further by arranging the inlet of the crude material to said conduit at the extreme bottom thereof, a result is obtained which is vital to the successful cultivation of the micro-organisms, as by this the crude material in the contracted conduit or chamber is kept constantly on the move, passing forward and upward without any place of permanent deposit, thus preventing the accumulation of stale organic and fecal matter which would destroy or retard the action of the micro-organisms.

His claim is:

> The herein described method of purifying sewage which consists in passing the sewage, without previous removal of the solid portions, under a suitable head, first through a concentrating chamber with contracted outlet openings in which the solid portions are retained until so far decomposed by the action of the micro-organisms that they can pass through the outlet openings, while the life products of the micro-organisms are allowed to pass out with the liquid and finer solid particles without delay, and then upward through a filter bed of suitable depth and of greater superficial area than said concentrating chamber, whereby the decompostion of the solid matters is substantially completed, substantially as described.

He carries his sewage to the bottom and lower compartment of the tank by means of a pipe and a horizontal chamber located at one end of such tank, and there discharges it. Here the solid matters are not disturbed and they remain until liquefied by the action of the micro-organisms which are here developed in such sewage. Means are provided for discharging any part not so liquefied or which the micro-organisms do not have time to liquefy. This is also done by the defendants, as it is found the Saratoga sewage plant does not wholly do away with sludge. This chamber or compartment at the bottom of the tank is necessarily air-tight and dark, essential conditions for the development and growth and action of the micro-organisms, whether Moncrieff actually knew the fact or not. This lower compartment, smaller than the one above it, is only separated from it by a numerously perforated diaphragm covered with filtrating substances, and as fast as the sewage in the lower compartment becomes liquefied by the action of these micro-organisms, or anaerobes, it rises through these numerous perforations and the filtrating materials into the upper part or compartment of the tank, and is thence discharged through numerous outlets located all along the side of the tank. The inventor has, therefore (1) a non-disturbing inlet for the sewage, opening and disposed below the normal water line of the sewage in the tank; (2) an air-tight and darkened tank in which the micro-organisms are developed and do their work of liquefying the sewage; (3) a filter bed through which the liquefied sewage must and does pass on its way to the outlet extending substantially the whole length of the tank; and (4) a non-disturbing outlet. And it is all done in a flowing current of sewage, as much so as in the patent in suit. He not only liquefies the sewage by the same process as the patent in suit, but, by direct connection and before it passes from the tank, he filters it. He does not aerate the liquid. He does not protect the sewage from light and air while the micro-organisms are doing their work according to nature's process by the "scum," but he does this by the filter bed and filtered liquefied sewage always standing above it. The result sought and obtained is the same as in the patent in suit. The work-shop provided for the bacteria while doing the work of liquefying the sewage is somewhat different. The process, so far as developing bacteria and liquefying the sewage is concerned, is precisely that of the patent in suit, viz.; the liquefaction of the raw sewage secluded in a tank or receptacle excluding light and air and free from all disturbances, except such as is incidental to the inflow and outflow of sewage, by the natural action of micro-organisms developed and grown in the mass of sewage at the bottom of the tank. Scott-Moncrieff may not have known just why and how this action took place, but he knew it did take place and he knew the result, and he provided conditions and means, the essential conditions and means, for producing the result sought. He is presumed to have known of the Mouras discovery that an air-tight tank was essential to the workings of the micro-organisms. He and Mouras, not Cameron, exploded the theory that the presence of oxygen was necessary and asserted the contrary. It is quite true, we find, that many contended for the presence of oxygen, but, nevertheless, the discovery had been made and published to the world that absence of oxygen was the one essential condition for the effectual development and working of these anaerobic bacteria, micro-organisms. It is immaterial that dozens or even hundreds of scientific men failed or refused to believe. It is also disclosed by the evidence that the so-called septic tank, in all essentials, was in use in Urbana, Ill., in 1894, and designed for Champaign, Ill., in 1895, and constructed in 1897. I will not take time to go into details or a description of these works.

Cameron's (the patent in suit) conception was to provide an "artificial method" for "the liquefaction and purification of sewage" by the action of anaerobic bacteria developed in a pool of the sewage under proper conditions. But this, as we have seen, had been done before, even if we may say that nature's method and means of doing a thing become an "artificial method" of doing the same thing when we provide a new place, an artificial place, or a place, like a tank, constructed by human hands, in which nature by its own instrumentalities is to perform its own process. The patentee declares (1) "The invention consists in certain methods of developing *in a flowing current of sewage* bacteria capable of dissolving the mass of solid organic matter contained therein," and (2) "of subsequently utilizing the so-developed bacteria in liquefying the *mass of organic matter coutaiued in the flowing current.*" If this means what it says, nothing of the kind is done. The bacteria or micro-organisms are not developed *in the "flowing current of sewage"* and cannot be effectually. They are developed in that part of the sewage which is at rest, and which has been brought to a "stand-still" secluded in a pool, and which must remain at a "stand-still" below the flowing current until the bacteria are developed and have actually liquefied it. Non-agitation, non-disturbance, non-flowage, are essential to the effectual development and action of the bacteria. The liquids of the sewage that do not require liquefaction flow along through the tank and pass out, but this part does not develop bacteria of the character mentioned. Hence the necessity for the deep tank in which the more solid parts of the sewage may remain at rest in a pool, deposited at the bottom, outside the "flowing current of sewage" for days, while the bacteria develop and work and liquefy this non-moving mass. When liquefied it returns to the flowing current of sewage, becomes a part of it, and passes on. And the bacteria after development do not liquefy "the mass of organic matter contained in the flowing current," but that part of the organic matter which has left the "flowing current," sunk to the bottom of the pool and remained at rest for the development and action of the bacteria. But in any event it is the same "flowing current" of the prior art as in Mouras, where the sewage entered at the inlet, was, except the fluid, deposited at the bottom of the tank for the development and action of the micro-organisms, or bacteria, and then, when liquefied by the operation of natural laws or processes, liberated and carried along in the flowing current of fluids, and as in Moncrieff and Adeney, fully described. Philbrick, Waring, [the towns of.—Ed.] Champaign and Urbana, had the same floating current and by-pool. All this was indicated and pointed out to him in the prior art with which he is presumed to have been familiar. The conception was not new or novel. I fail to discover any new or novel method of developing bacteria, or of allowing or permitting or enabling them after development to do their work of liquefying the sewage. They develop as they always had done and always will do under certain conditions, and when developed they liquefy certain materials, as they always had done and as they always will do if not prevented. Pasteur discovered the difference between and gave the names "aerobic" and "anaerobic" to certain bacteria or micro-organisms to distinguish those which develop and exist in the presence of free oxygen from those which do not. Mouras and Moigno and many others knew that an air-tight receptacle did not contain free oxygen, and that therefore aerobes did not liquefy the sewage contained in such an air-tight receptacle or tank. As already stated, Mouras and Moigno had discovered and published to the world the fact that sludge would not form in such a sewage receptacle or tank having a submerged inlet and outlet. Cameron did not, as shown, even discover "the scum." His tank must be air-tight in the beginning of nature's process going on therein, but when "the scum" is once formed it may be opened. Therefore his discovery of the utility of "the scum" is not a patentable invention. He has dispensed with nothing, he has added nothing. He has, we will assume, found in nature's process an aid, not to his process, but to nature's process, a part of it, and Cameron utilizes it at a later stage in that he may leave his air-tight tank open after the bacteria have been developed and have constructed their own roofing. This discovery, if it be Cameron's has not enabled him to even modify the tanks of the prior art. Clearly the formation of this scum or its use is not a part of a patentable process.

A principle is not patentable. Le Roy et al. v. Tathamm, 14 Howard, 156; O'Reilly v. Morse, 15 Howard, 62; Corning v. Burden, 15 Howard, 252, 267; see, Risdon L. W. v. Medart, 158 U. S., 68, 77, 78; Boyd v. Cherry, 50 F. R. 2,791.

It is when the term process is used to represent the means or method of producing a result that it is patentable, and it will include all methods or means (not nature's) which are not effected by mechanism or mechanical combinations. Corning v. Burden, 15 Howard, 252, 267; approved Risdon L. W. v. Medart, 158 U. S. 77. We may have a valid patent for the means or methods of putting principles into operation so as to produce useful results, but not for nature's means and methods. Those are common property and cannot be appropriated and monopolized by any one.

It was discovered years ago, before Cameron came into the field, that sewage, in an air-tight tank, or receptacle of any kind, having an inlet and an outlet, both submerged therein or opening in the tank below the level of the contents, would generate or develop active bacteria, or micro-organisms, which, feeding on such sewage and on the newly arriving sewage, would so act upon it as to liquefy it permanently, leaving no great amount of residue or sludge. It is true that the principle was not fully comprehended and understood, but enough was known and understood to enable the prior art to construct and use their "septic tanks" with a flowing current of sewage, secluding in the tank under the proper conditions a pool for the development and action of the bacteria. This result was obtained in the prior art by the process of the patent in suit. This development of bacteria is a fundamental truth in nature. In patent law it is a principle. It is a process of nature, but a principle and not patentable. But if patentable Cameron was anticipated.

Now take the means for bringing this principle into operation, for making it serviceable to man, the process of liquefying sewage by anaerobic action. We have, with Cameron, the air-tight tank or receptacle with the inlet and outlet demanded. The raw sewage flows in and remains at rest while the liquids coming in and those produced by the anaerobic action flow out. Nothing whatever is done to the sewage after its arrival. It must be left undisturbed. In fact, it must not undergo any process whatever except the natural one; that is, let nature take its course. It is like a process for fermenting cider or improving whiskey. Run it into the barrel or tank where it will not freeze and let it alone. But all this had been done before. Assume that Cameron discovered that these anaerobes would in an air-tight and dark receptacle construct a covering for themselves by the formation of the scum. His process has nothing to do with that. It is a principle and not patentable. But he did not discover it, as we have seen. Moigno twice describes it. But, it is said, he has improved the means, and therefore has an improved process. But we have seen that his process is old, his means old, except, possibly, in some mechanical details. In the sewer pipes, entirely outside of and away from the tank, he has put in the old settling tank or catch-basin of the prior art for stone, iron, bones, &c. Outside the tank, at the other end, he has attached an aerator, or, more properly, aerating means, which deals with the liquid after it has left the tank, and then he adds to that the filter, all old devices. Each performs its old function in the old way, and each acts independently of all the others and is independent of the tank and the process going on there. This is mere aggregation and not patentable. Atlantic Works v. Brady, 107 U. S., 192, 199, 200; Pickering v. McCullough, 104 U. S., 310, 23 L. Ed. 749; Dodge Coal Storage Co v. N. Y. C. & H. R. R. Co., 139 F. R., 976, affirmed by C. C. A. January, 1907.

The process described in claims 1, 2, 3 and 4 is nothing more nor less than the process of Mouras and of Moncrieff and the ones in use at Champaign and Urbana. It should be mentioned that Mouras took out a patent in the United States in 1882 for his process, No. 268,120, and that he had a device in the tank itself for intercepting bone and other hard substances. The same is true of claim 21, for it cannot be doubted that the scum existed in all those cases and did its work, although its office or function in nature's process may not have been understood. The process described had become public property in the United States before the patent in suit was applied for. To hold these claims valid would make an infringer of every one who shall use the Mouras tank with its inlets and outlets. Certainly so, should such use apply to it the broadened inlets and outlets of the prior art, that is, the devices of the prior art used in sewage disposal, &c., prior to the Cameron patent. I cannot discover any new "conception" in the patentable sense in the patent in suit. I do not doubt that it improves some of the mechanical devices at the outlet. I do not doubt that it was a "good thing" to connect the aerator to the "septic tank" and then connect that to the filter, but I do not find patentable invention in so doing.

Coming to the defendant's sewage disposal plant we find: (1) a large oblong tank constructed of solid masonry, made air-tight by a roof covered with earth and supported by arches and pillars. It is also provided with manholes which may be left open. The sewage is brought to this tank or receptacle in a pipe or conduit extending all along one end, or nearly so, and enters through a main or mains into a pipe located on the inside of the tank which [pipe] extends, in length, nearly the width of the tank, and is properly supported, by a concrete bracket reinforced by railroad iron, some 3½ ft. below the water level. This discharges the sewage into the tank proper at four points (as shown in blue print drawing).* In every essential it is the means of ingress or inlet of the Walker, 1864, patent. It is an improvement on that, doubtless, but it is far from the inlet of the patent in suit. As to the outlet the description in the Engineering Record says, "The septic effluent is discharged at the opposite end" (of the tank)" through 96 2-in. pipes, in two horizontal rows, also 3½ ft. below the high water line, in a narrow chamber extending the width of the tank. From this chamber it flows over a weir into an outer chamber, and thence through an aerator to an adjacent dosing tank." These 96 pipes are simply holes in the wall in which the pipes are inserted. There is no slotted pipe or pipes on the interior. Nor is there one on the exterior to aid in the outflow from the tank itself. The "narrow chamber" is outside the tank and is under cover, as is the outer chamber. There is no current to any central point, and hence no disturbance or breaking up of the scum. There is no aeration on leaving the tank. From the outer chamber the effluent is carried by a large pipe some considerable distance to the aerater, located at about the center of the filtration beds, twenty in number, covering an area of some twenty acres. Here "the liquid rises through the central pipe" and then is discharged and flows over the "sheet-iron plates of the aerator hung in three layers around a central riser pipe." Thence it is carried to the filter beds. We do not have either the inlet or the outlet of the patent in suit, nor its aerator. Much more nearly do we have the outlets of the Wigner and Meyer patents, found in the prior art before Cameron came into the field. We do not have the same combination of elements, taken as a whole, found in any one of the "apparatus" claims of the patent. If they, or any one of them, have any validity whatever in view of the prior art they must be very narrowly construed and limited to the inlet and outlet and other devices shown therein. As so construed and limited, defendant's sewage plant does not infringe any apparatus claim. Complainant cannot claim the "septic tank" broadly, for it is in the prior art. He cannot claim the inlet described broadly, for that, too, is in the prior art. Even if he may claim his specific outlet broadly, defendant does not infringe, for he does not use it. As to the process claims, claim 1 is plainly invalid, anticipated and long in use prior to the Cameron patent. As to the other process claims, while in my opinion invalid, as not disclosing patentable invention in view of the prior art, and because of prior public use, &c., still, if either has any validity, in view of the prior art, it must be narrowly construed and limited to the exact process performed by the means described in the Cameron patent, and as so construed and limited defendant does not infringe. The Cameron process, if it be a process, consists in constructing a tank in a certain way in which to enable a process of nature to be performed, and as he has borrowed the tank, the inlet, and, in the main, the outlet from the prior art, changing or improving no element, except it be the outlet apparatus, and produces no new result, the defendant does not infringe in using the old tank, and inlet with an outlet entirely different from Cameron to produce the same result. In fact, the inlet, and outlet, and aerater, and filter, all are essentially different from Cameron. But I prefer to base my decision on the broad ground that the claims in suit of the Cameron patent, in view of the prior art, are invalid for want of patentable invention. Cameron may have carried forward discovery in this art, and may have improved means, but as defendants' process and apparatus are clearly differentiated there is no infringement. Cimiotti Unhairing Co. v. American Fur Refining Co., 198 U. S. 399, 414; Kokomo Fence Machine Co. v. Kitzelman, 189 U. S. 8. Not every improvement in an article or process is invention. The improvement must be the product of original conception. Pearce v. Mulford, 102 U. S., 112, 118; Slawson v. Grand St. r., 107 U. S., 649; Muorson v. N. Y. City, 124 U. S., 606.

There will be a decree for defendants, dismissing the bill with costs.

◆

CREMATION IN GREAT BRITAIN in 1906 numbered 742 bodies, as compared with 604 in 1905, according to a report by Consul F. W. Mahin, of Nottingham, England. Municipal crematories are in existence at Leicester, Hull, Leeds, Hilford, Bradford and Sheffield, in addition to a number elsewhere privately owned. Those interested in this subject can find a considerable number of statistical tables, covering various foreign countries and the United States, in the report of the Board of Health of Boston, Mass., for the year 1905.

[*The Saratoga sewage works were described at length in Eng. News, Feb. 2, 1905.—Ed.]

A REINFORCED CONCRETE FORM FOR CONCRETE CONDUITS.

By W. L. BUTCHER,* Assoc. M. Am. Soc. C. E.

An important consideration in the use of concrete as a structural material is the design of the forms or molds for holding the material until it becomes self supporting.

With the advent of reinforced concrete and its use in all manner of structures, the cost of forms has become a serious item, particularly in heavy construction or where the design calls for members of diversified shapes such as occur in buildings. The rapid accumulation of data and formulas tending to reduce the actual work of design is permitting engineers to divert their energies toward the solution of problems relating to forms.

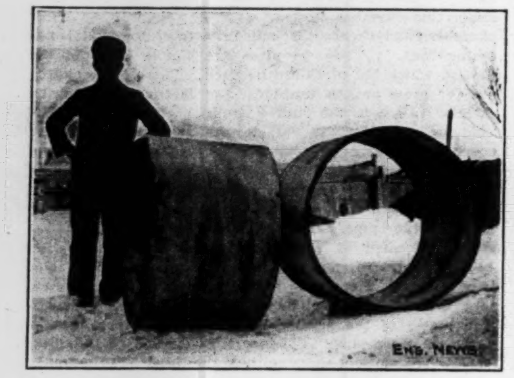


Fig. 1. Reinforced Concrete Conduit Linings, to be Afterward Used as Centers for Concrete Conduit.

Although in the matter of conduit design, owing to the nature of the structure, the problem regarding forms is a simple one, other considerations aid in giving weight to the method outlined below. The inside surface of a concrete aqueduct or other structure for carrying water must usually be covered with some less permeable material. While necessity generally dictates the employment of some lining, its cost is often more than justified by reduced friction losses and consequent allowable reduction in the interior dimensions of the structure. A plaster often employed consists of a paste of cement mortar. This, if placed after the work is completed, tends to crack and flake off, leaving the interior in a worse condition, as far as friction is concerned, than if no lining had been attempted. Numerous expedients have been utilized at various places, often at considerable expense, the object of all of them being to deposit the lining and the concrete simultaneously or within a short time of each other, so that a satisfactory bond may be established between the two.

The following method consists essentially in making the lining serve as a centre during construction. Sheet iron molds are used to form thin shells of rich cement mortar of such thickness and length as to be readily handled and placed in the work.

In the experimental conduit illustrated in the photographs the shells, which were 1-in. thick, 3 ft. in diameter and 2 ft. long, were made by pouring a mixture of one part cement and three parts sand into molds, in which a light reinforcement of wire cloth had been centered. These cylinders, although easily handled, without injury, were apparently not rigid enough for thoroughly satisfactory work, and 1½ in. thickness would have been better. The conduit was constructed by setting up a bulkhead at either end, in the lower part of which a segment had been cut out, leaving a curve conforming with the contour of the outside of the shells. By the aid of these curves as a screed, concrete was placed in the bottom and for some distance up the sides. The cylinders, handled by two men, were then placed in position and the concreting completed.

The advantage claimed for this mode of construction is that by its means conduits of four or five feet in diameter or less may be built with a thoroughly homogenous inner surface of excellent hydraulic properties, at a cost no greater and often less than by the use of temporary centers. The expense of making the mortar shells is not greatly in excess of the cost of an efficient plaster. The labor of placing forms is practically the same in either case, while in the procedure advocated in the above construction the cost of moving centers is obviated.

Furthermore, for the construction of conduits designed to run under pressure, where all of the tension would be provided for by reinforcement, the steel, which in this case could properly be placed near the inner surface, would be wound on the shells before placing in the work. Under these conditions a distinct saving of expense would be made due to the facility of handling the reinforcement. By this device such structures would be built, having many of the advantages of pipe constructed before placing in the work and without many of the disadvantages due to its great weight, liability of injury and to problems of satisfactory joints incident to this form of construction.

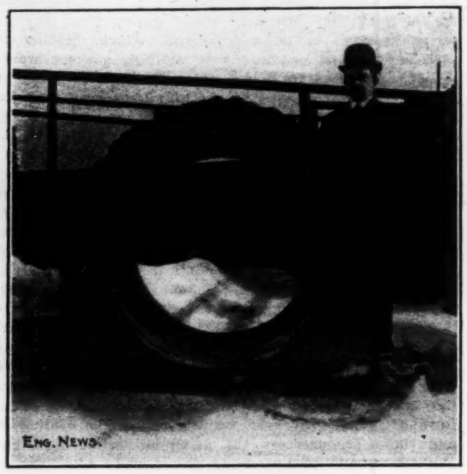


Fig. 2. Finished Conduit Built with Reinforced Concrete Lining Used as Centering.

THE ANNUAL CONVENTION OF THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION.

The eighth annual convention of this association was held at the Auditorium Hotel, Chicago, March 19 to 21, with an attendance of about 225 members. Of the 17 committees, all but three had printed reports, and every one of these was taken up and discussed. A notable feature was the number of comparatively short reports, as compared with the array of voluminous reports which have been presented at some of the former meetings. It does not appear that there has been any corresponding decline in quality, and the very brevity of the reports greatly facilitated the proceedings of the convention. During some of the sessions there was a marked decline in both quantity and quality of the discussions, some matters of importance being passed over or acted upon in a somewhat perfunctory manner. This was especially the case with the report on signaling, which was accepted almost without discussion, in spite of the fact that it recommended an entirely new system of signaling, which is as yet in use only experimentally and on a very short stretch of road. The fact that the Railway Signal Association had taken similar action previously appeared to be considered reason enough for the adoption of the report, with its somewhat radical recommendations.

There were seven business sessions, with no excursions or entertainments to interfere with the proper conduct of the proceedings. The annual dinner was held on the evening of March 20. There was the usual extensive and elaborate display of railway material and appliances, mainly arranged in the parlors of the hotel, and overflowing into various private rooms, the available space on the parlor floor being insufficient to meet the requirements.

At the first meeting, the President, Mr. H. G. Kelley, Chief Engineer of the Minneapolis & St. Louis Ry., read the annual presidential address. This was brief, but showed the important position which the association has already attained in railway affairs. It is represented on the National Advisory Board appointed by the President; it has a committee cooperating with one from the American Railway Master Mechanics Association, in considering the question of gage on curves; and by request of the American Railway Association a special committee has been appointed to confer with one from that association upon the subject of third-rail conductors and their relation to equipment in connection with the electrification of steam railways. In addition to this, a special fund is being raised for the purpose of conducting impact experiments on steel bridges, under the direction of the association's committee on iron and steel structures. All these lines of active work are supplementary to the regular work of the several committees. The reports of the Secretary and Treasurer presented the following summaries: Number of members, 602; receipts during 1906, $11,180; expenditures, $7,773; balance, $3,407.

UNIFORM RULES.

The Committee on Uniform Rules and Organization was the first to present its report. It has undertaken the revision of the general rules for employees in the maintenance-of-way department, and presented two sets of rules for the government of supervisors of track and structures, respectively. They are compiled on the basis of the rules now in force on different roads, and were adopted with little discussion. Practically the only point of importance was in regard to the inspection of bridge and culvert openings. The rules provide that the supervisors of track (or roadmasters) must see that such openings are kept clear of brush and driftwood, while the supervisors of structures must see that the openings are of adequate capacity. It was suggested by Mr. Cushing (Pennsylvania Lines) that such openings should be inspected after heavy rains, with a view to determining safety as well as capacity. Mr. MacPherson (Canadian Government Transcontinental Ry.) thought that the high-water level should be marked at time of flood, so that the question of capacity may be studied afterwards by the division engineer. The rule governing supervisors of structures in regard to this matter was finally amended as follows:

> They shall, in period of flood, observe and record the flow of water of the various streams passing under the track, and report to the proper officer from time to time where the area seems to be insufficient.

BALLASTING.

This brief report referred to the analysis of strength of track and supporting power of ballast recently prepared by Mr. Selby, an abstract of which was published in our issue of Feb. 14, 1907. It also presented a bibliography of ballast and ballasting. The principal feature of the report was a set of proposed cross-sections for ballast of different materials. The minimum depth of ballast under the ties is given as 12 ins., 9 ins. and 6 ins., for lines of heavy, medium and light traffic, respectively, this minimum to be used only on the most substantial and well-drained sub-grade. In all cases the ballast slopes ½-in. in 12 ins. from the top of the tie at middle of track to the middle of the tie at the ends, except that with cementing gravel and chert the slope runs to the bottom of the end of the tie. The question of sodding the slopes was discussed, and it appears that the importance of this is beginning to be recognized in this country. The recommendations were for the sod to extend over the edge of the bank to within 12 ins. of the ballast (changed to 8 ins.), and while some members thought this might interfere with drainage, it appeared that it has been found very satisfactory on the Pennsylvania

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*211 Lake View Ave., Cambridge, Mass.

Lines, the Illinois Central, the Delaware, Lackawanna & Western, and other important lines. It was also voted, on motion of Mr. Baldwin (Ill. Cen. Ry.), that the sodding should also be employed in cuts, covering the ditches and extending over the edge of the roadbed and up the slope of the cut.

SIGNALING AND INTERLOCKING.

This report was taken up at the opening of the afternoon session, but although it made some most radical recommendations, it failed to arouse much discussion or interest, and the recommendations were adopted by votes of a very colorless character, very few members taking the trouble to vote at all. The most striking feature of the report was the recommendation to incline the semaphore upward instead of downward, at 45° for caution and 90° for clear. The movements would thus be in the upper right-hand quadrant, although it was remarked that the signal committee of the American Railway Association has shown some preference for the upper left-hand quadrant. While similar recommendations have been adopted by the American Signal Association, and while there may be advantages in such a change, the reasons given by the committee for making this recommendation appear to be singularly weak.

A matter which was discussed at greater length was that of the division of expense of the operation and maintenance of interlocking plants. The committee recommended a division on a basis of units operated, but Mr. Rhea (Pennsylvania Lines) and others considered that the division cost of operation should be on the basis of the number of roads interested. The committee presented standard specifications for mechanical interlocking and material for construction work, which were adopted. The association also adopted the following recommendation as to lights: red, danger; green, clear; yellow, caution. The use of a system calling for two lights for each indication was objected to as making it difficult for an engineman to pick out a particular signal, but Mr. Anthony (Pennsylvania Lines) thought it would be actually easier, even at terminals.

ACCOUNTS AND DRAWINGS.

The report of the Committee on Records, Reports and Accounts presented a simple system of blanks for use in the estimates of cost and the formal authorization of the expense of items of construction, addition, or betterment work. Thus, for any piece of work, the chief engineer invites bids, and after these are received and tabulated he is ready to let the contract; before doing so, however, he makes a requisition on the vice-president or general manager for the necessary authority and funds, using the specified blank form. The authority is received on another form, and the contract is then let. The system is elastic enough to suit all conditions, whether for large or small expenditures. It can also be used by division engineers in handling work under the engineer of maintenance-of-way, or by resident engineers in handling work under the chief engineer.

The committee presented a series of conventional signs for use on maps and drawings, including a number used by Engineering News and by various railways, together with those which were recommended by the committee. This is the result of several years of hard work in classifying individual practice and selecting the simplest and most significant signs for recommendation, and is expected to prove of great use in ensuring simplicity and uniformity.

ECONOMICS OF RAILWAY LOCATION.

The evening session on March 19 was devoted to the consideration of the very lengthy preliminary report presented by this committee, but no action was taken in view of the fact that it was only a preliminary report, submitted as information. After a discussion of the question of location as related to new lines and the improvement of existing lines, about 90 pages of the report were occupied by an interesting and valuable review of train resistance experiments, beginning with those made in 1818 and 1824 by Nicholas Wood and George Stephenson. No less than 60 formulas were given, discussed and compared, and copious extracts were given from technical literature bearing on the subject. In the discussion, the relation of curves and of the positions of signals to questions of location and train resistance were briefly suggested. The committee considered that in experiments as to train resistance the speeds should be determined with greater precision than is usually in the case. It also presented the following conclusions:

(1) Each company should conduct its own experiments for train resistance.

(2) For the present the dynamometer method should be used, and the resistance of train alone determined.

(3) The determination of the amount of pull available at the drawbar at various speeds for locomotives of the different classes should be left to the proper motive-power officials.

(4) Speeds should be determined as closely as 1-10 mile per hour.

(5) For experiments on heavy freight trains at low speeds, the formula should have the shape $r = a + b V$.

(6) An additional term should be added to show the effect of loading.

(7) All tests for train resistance should be made on tangents.

(8) For determining the sum allowable to save curvature, or to save rise and fall, the average line for train resistance should be used.

(9) For grade revision, for questions of momentum grade, a maximum line above the average train resistance should be used, a line somewhat near the outer edge of the experiments plotted in a diagram.

BUILDINGS.

At the morning session on March 20, the report of the Committee on Buildings was first presented. This dealt mainly with current practice in designs for locomotive coaling stations, and some extracts from this part of the report are given in another column. The report also referred briefly to the subject of covering or roofing freight-car repair tracks, and referred to a particular instance where this has been done with satisfactory results. The building has a steel frame, brick walls and saw-tooth roof; it is heated by warm air, equipped with compressed air and electric light, and has a plate furnace and the necessary machinery for repairing steel cars. There are six car tracks, 24 ft. c. to c., and each pair of tracks is served by a material track between the two car tracks. Over one pair of tracks is a 40-ton electric traveling crane for handling the bodies of loaded cars needing repairs; each of the other pairs is served by a 20-ton crane. All the cranes are used for raising car bodies, handling material and trucks, and placing the car bodies on the trucks. This is for heavy repairs. The advantages claimed for doing car repair work under cover are as follows: (1) Reduction in cost of work done, due to the use of power; (2) reduction in cost of labor, due to comfortable surroundings; (3) better class of labor available with continuous service; (4) no loss of time in bad weather; (5) night work can be done, and full time worked in winter by use of artificial light.

The discussion on this report related mainly to opinions as to different types of coaling stations. Mr. Wendt (Pittsburg & Lake Erie Ry.) referred to the very complete plant at McKees Rocks, Pa., for coaling, watering and cleaning fireboxes. This was described in Engineering News of March 22, 1906. One force of men attends to the coaling, filling water tanks, running the water softening plant, cleaning fireboxes, and removing ashes from the pits.

ROADWAY.

The principal feature of this report was its series of recommendations as to steam shovels for general construction work, and this is a matter of such general interest and importance that we shall publish it separately in a later issue. The report was received with very little discussion.

IRON AND STEEL STRUCTURES.

At the afternoon session, the Committee on Iron and Steel Structures presented a brief report of progress. During the past year it has investigated and discussed the question of changing the desired ultimate strength of structural steel from 60,000 lbs. to 62,000 lbs., and also the advisability of lowering the phosphorus limit in acid steel castings from 0.08% to 0.06%; it was not prepared, however, to recommend any change in the specifications as adopted last year. The most important part of the report was a brief statement in regard to the problem of determining by experiment the dynamic effect of live loads on bridges. For making impact experiments of this kind, an instrument for measuring deformations under strain has been perfected by Prof. Turneaure, and built at the University of Wisconsin. Several satisfactory trial experiments have been made with this instrument, and the Association proposes to raise funds for prosecuting effective experiments in this direction. In the discussion several members offered their assistance in the application of the device to structures on their roads.

WOODEN BRIDGES AND TRESTLES.

The committee presented specifications for workmanship for pile and frame trestles to be built under contract. Similar specifications were presented in 1905 and 1906, but were withdrawn by and referred back to the committee at the respective meetings. As now presented they were adopted after some discussion as to certain items. The requirement that holes should be bored for spikes as well as for drift bolts was struck out, and it was suggested that the iron rings for the butts in driving piles should be furnished by the contractor, as a part of his equipment, rather than by the railway company. One speaker considered that piles should have the bark stripped off, and that steel shoes are objectionable, as piles thus fitted will continue to work down under the effect of traffic. The report presented a list of standard names for defects in structural timber, and also standard names for such timbers. These were adopted but not until after some discussion as to the classification of "southern yellow pine" into "longleaf," "shortleaf" and "loblolly" pine; a committee of the American Society for Testing Materials divides this species of timber into the first two classes only. These lists were prepared as preliminary to the preparation of specifications for timber used for structural purposes, and at the present time the common name for some timber is applied in different parts of the country to different species, while different terms are used to define practically the same kind of defect. The report was adopted as a report of progress.

TIES.

The recommendation as to sizes for ties met with strong objections. The Association has adopted an arbitrary classification of railways into three classes according to their traffic conditions, and at the meeting of 1906 this committee were directed to submit sizes for ties for these three classes. As submitted they were as follows: First class, 7x8 ins., 8½ ft. long; second class, 7x8 ins., 8 ft. long; third class, 6x8 ins., 8 ft. long. It was pointed out very forcibly that third class track is liable to have but a minimum quantity of ballast, and that therefore it really needs large ties (acting as sills or sleepers) more than does a well-ballasted track. Mr. Curtis, of the committee, stated that direct inquiries sent to a number of roads had failed to produce any real objection to a tie 6 ins. thick, and that the principal reason for using a 7-in. tie is the use of larger spikes with heavier rails. Mr. Faulkner (A. T. & S. F. Ry.), of the committee, said that figures presented at the International Railway Congress in 1905 showed that out of 50 railways in this country 30 leading roads were using ties 6x8 ins., 8 ft. long. To this it was replied that it was not necessarily advisable for the association to recommend such ties as good practice. Mr. Wendt (P. & L. E. Ry.) thought it would be better, in view of the widely varying dimensions of ties in use, to recommend the number of ties of different widths that should be used for a rail length. As far as width is concerned, with narrower ties there must be a greater number used to give sufficient bearing for the rail, which in turn involves a greater number of spikes and a greater amount of tamping and maintenance work. The discussion was continued at the morning session on March 21, and the feeling was strongly against such a compromise recommendation as that produced by the committee, and the matter was referred back for further consideration. It was also voted to submit to letter ballot the question of the advisability of recommending specific sizes of ties.

The committee had been instructed to look into the use of steel ties and concrete ties, and it presented in its report a statement made in 1904 regarding a number of reinforced-concrete ties that have been tried experimentally. It did not bring the matter up to date, however, and had nothing to say about steel ties except to suggest the difficulty of insulating them from the rails where signal circuits are employed. As a matter of fact there are many more steel ties than concrete ties in actual use in this country, and the committee might well have given this subject some attention. At a later time in the convention, Mr. Crawford, of the U. S. Forest Service, spoke briefly as to the destruction and disappearance of the sources of the best quality of ties, and the necessity of utilizing what have been considered inferior timbers, together with various preservative processes.

SIGNS, FENCES AND CATTLEGUARDS.

This committee had worked on the system of sending out a circular letter with a list of inquiries, and its report consisted simply of a summary as to several practices in regard to farm gates, road crossings, etc. The pneumatic gate is in general favor for road crossings, and has an advantage over the gate operated by chain and wire connections in reduced cost of maintenance. The use of metal signs set in concrete is limited to a few roads, which believe in their ultimate economy. There is a more general use of metal signs on wooden posts, but the majority of railways use wooden signs and posts. Although metal signs are smaller than those of wood, their cost is from double to treble that of the latter.

SWITCHES AND FROGS.

The report of the Committee on Track presented recommendations as to the construction of switches and frogs, which were discussed in rotation and all referred back to the committee as unacceptable. A length of 16½ ft. for switch rails, simply because many 33-ft. rails are now used, was considered quite unnecessary, while the recommendation that they should be of open-hearth steel was condemned partly on the ground that it is doubtful if they could be obtained and partly because it is not yet known that such rails are specially advantageous for switch points. The statement that frogs of manganese steel are the most economical for yard service was shown to be incorrect as a general proposition; it would depend primarily on the traffic, while such frogs are in many cases used in main track service. The committee recommended a frog guard-rail 11 ft. long, with sharply flared ends and a 2-in. flangeway; it was pointed out that the width of flangeway should not be arbitrarily fixed, but that the guard rail should be set at the standard distance of 4 ft. 6¾ ins. from the gage side of frog to conform to the M. C. B. standard distance between backs of wheels. A 15-ft. rail with ends flared for a distance of 3 ft. was advocated by some, while Mr. Baldwin (Illinois Central Ry.) considered that the rail should be straight only opposite the frog point, all the rest of its length being flared. The practice of raising the switch rail to carry the false flanges of worn wheels clear of the stock rail was referred to, and the suggestion made that it might be better to depress the stock rail. Mr. Kittredge (N. Y. Central Ry.) and Mr. Wendt (Pittsburg & Lake Erie Ry.) have had extended experience with switches in which the heads of both rails are at the same level, and find this entirely satisfactory to both the maintenance-of-way and the motive-power departments.

The committee recommended that main-track switches should be equipped with distant signals operated by wire from the switchstands, and proposed a semaphore signal similar to that employed at interlocking plants. Mr. Clausen (C. M. & St. P. Ry.) considered this objectionable in many ways, and largely because it would confuse switches controlled by interlocking plants and by switchstands. The drawings illustrative of the committee's proposed standards had not been made by a draftsman familiar with reproduction work, and the figures and lettering were illegible. It was voted that suitable drawings should be made for publication.

OTHER REPORTS.

At the afternoon session, the Committee on Water Service presented a report dealing very thoroughly with the use of water softening plants for railway water stations. It included a number of formulas for calculating the relative economy of different chemicals. This report was adopted, and an abstract is given in another column. In the discussion, Mr. Raymer stated that, as the result of extended experience, the Pittsburg & Lake Erie Ry. now has water softening plants all along its line and supplies all its engines with treated water exclusively. The Committee on Masonry reported progress on certain lines of work, which it is investigating in cooperation with the joint committee on Concrete and Reinforced Concrete. It also presented in revised form the specifications for stone masonry which were discussed at considerable length at the meeting of 1906. The Committee on Classification of Track reported the adoption by letter ballot of the classification (based on train speed and car mileage) proposed in its report last year. The Committee on Rails and the Committee on Yards and Terminals simply reported progress.

OFFICERS.

The officers for the present year are as follows: President, A. W. Johnston, General Manager of the New York, Chicago & St. Louis Ry.; Vice-Presidents, Walter G. Berg, Chief Engineer of the Lehigh Valley Ry., and W. McNab, Assistant Engineer of the Grand Trunk Ry.; Treasurer, W. S. Dawley, Chief Engineer of the Missouri & North Arkansas Ry. The Secretary is E. H. Fritch, 962 Monadnock Block, Chicago.

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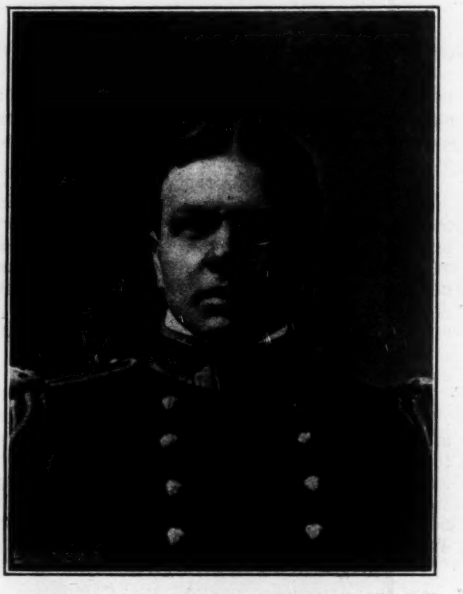
THE LATEST PANAMA CANAL COMMISSION APPOINTEE: REAR-ADMIRAL H. H. ROUSSEAU.

The appointment of Rear-Admiral Harry Harwood Rousseau, Civil Engineer, U. S. N., to membership on the Panama Canal Commission, took effect on March 16. Rear-Admiral Rousseau, whose portrait is shown herewith, was born in Troy, N. Y., in 1871. Twenty years later he graduated in the civil engineering course of the Rensselaer Polytechnic Institute, at Troy, N. Y. In 1898 he entered the Corps of Civil Engineers, U. S. Navy Department, after passing a competitive examination in which he ranked first. From 1898 to 1901 he was engineer in charge of drafting and designing in the Bureau of Yards and Docks, Washington, D. C. From 1903 to 1906 he was located in Mare Island Navy Yard, where he applied the jetty principle by means of timber bulkheads to the clearing and deepening of Mare Island Strait. He succeeded Rear-Admiral M. T. Endicott as Chief of the Bureau of Yards and Docks, Jan. 5, 1907, and will succeed the same officer as member of the Isthmian Canal Commission in the near future. Admiral Rosseau sailed for Panama on March 15.



Rear-Admiral Harry Harwood Rousseau, Civil Engineer, U. S. N.

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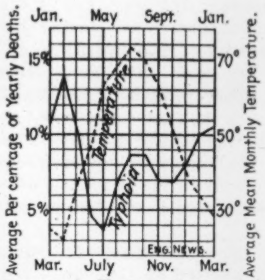
THE RELATION BETWEEN SEASONAL TEMPERATURE AND TYPHOID FEVER AT YOUNGSTOWN, O.

In our issue of Jan. 10, 1907, we published an article entitled "Report on the Prevalence of Typhoid Fever at Youngstown, O., after Installing Water Filters." A diagram designed to illustrate the relation between temperature and typhoid fever during the years 1893 to 1905 was omitted from the article and is published herewith. The explanatory text is here reprinted, as follows:



Seasonal Temperature and Typhoid Curves at Youngstown, O., 1893 to 1905, Inclusive.

> To aid in forming conclusions as to the effect of the public water supply and other causes upon the typhoid death rate, Mr. Hansen platted the average monthly typhoid death rates for the 13 years 1893 to 1905, expressed as percentages of the average yearly death rate for the same period, and also platted on the same diagram the average monthly temperature at Youngstown for the years named. The temperatures were taken two months in advance of the typhoid rates, in order to give time for the effect of the former on the latter.[*] The resulting diagram is reproduced herewith. The "rise in typhoid cases in the winter and spring months" appears to show "that during the 13 years considered a large number of typhoid fever deaths" were "due to the public water supply," and the peak in late summer "indicates conclusively that the city has always suffered from a considerable amount of typhoid fever due to general causes."

◆

THE GREENWICH OBSERVATORY, as noted in our issue of July 12, 1906, p. 47, was said to have been seriously affected by the generating station of the London County Council, which is being enlarged to twice its original size. The report of the committee, which was appointed to investigate the disturbances, was lately published in "Electrical Engineering." This committee made numerous observations and experiments, both as to the effect on the instruments of the observatory, of the vibrations caused by the engines of the power station, and also as to the discharge of the chimneys. Although they found that the engines caused vibrations of the ground, which were felt at the observatory, and which caused images in the telescope to oscillate, they found no evidence that the observations of stars were materially affected. As regards the chimneys and their discharge, the committee found that the two old ones did not seriously affect observations, while one of the two new ones was directly in the altazimuth line and if carried to its projected height would block meridian observations. The committee remark that it was poor judgment that ever allowed the power plant to be placed so near the observatory (one-half mile), but in view of the great expense involved and the lack of proof that observations were being seriously affected by the plant, they thought it inadvisable to move the plant or to stop the completion of the new portion. In consideration of these facts they made recommendations which they summarized as follows:

> (a) The question, both as regards effects of vibration and obstruction through chimneys or discharge from chimneys, to be further reviewed after, say, two years, by which time experience should be obtained with the second portion of the station at work.
>
> (b) The generating plant for the second portion to be turbines which, as well as the dynamos, must be of a perfectly balanced type such as has been proved by trial not to cause vibration.
>
> (c) An undertaking to be obtained that when the plant in the second portion is available for use, the reciprocating engines of the first portion shall not, in ordinary circumstances, be used after 10 p. m., and their use shall be restricted as far as possible after 8.30 p. m.
>
> (d) The two chimneys of the second portion, at present incomplete, to be not higher than 204 ft. above Ordnance datum.
>
> (e) The discharge of gases both from these and from the existing chimneys not to be materially hotter than the discharge is now from the existing chimneys, namely, about 250° F.
>
> (f) No further extension of the station to be made beyond the 20,000 KW. now contemplated in the equipment of the second portion.

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[*] Mr. Hansen here followed the studies of seasonal temperatures and typhoid made in 1902 by Profs. Wm. T. Sedgwick and C.-E. A. Winslow, as published in Memoirs American Academy of Arts and Sciences, Vol. XII., No. 5, pp. 521-71, with plates (Boston, 1902). A number of the diagrams in this paper are reproduced in Mr. Hansen's report.—Ed.

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Entered at the New York Post-Office as Second-Class Matter.

Some of the points in Mr. Johnson's paper on water meters and water consumption, abstracted at length elsewhere in this issue, will come as a shock to many believers in universal metering. Mr. Johnson, however, as we understand him, does not dispute the advantages of meters, but merely points out several particulars in which he believes their continuous efficiency for the prevention of considerable increases in water consumption has been overrated. The paper was read before the New England Water Works Association on March 12, and as our condensation of the paper is followed by an abstract of the remarkably spirited discussion that was aroused by it we shall not attempt at this time to present any criticisms of our own. Lest any one should get the impression that Mr. Johnson's paper is merely controversial in character, we would say in conclusion that it abounds with interesting and valuable data on water meters and water consumption, the like of which has never before been brought together.

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The septic tank as a preliminary means of sewage treatment has come to play such an important part in sewage disposal that the decision on the lawsuit involving the validity of the United States patents granted to Mr. Donald Cameron and others in 1899 has been awaited with great interest. That decision was rendered on March 12 and was in favor of Saratoga Springs and the associated defending cities. Although this decision was rendered in one of the lowest United States courts and, we are informed, is to be carried up on appeal, yet it is so interesting, as a review both of the claims of the Cameron septic tank patent and of many phases of the prior state of the art of sewage treatment, that we devote to the decision this week the large amount of space required to print it in full. Since the validity of the patents has not been finally settled, comments upon that phase of the decision would be ill-advised, further than to point out that in the opinion of the lower court neither the septic tank process nor any of the elements in combination claimed in the patents are infringed by Saratoga Springs. By inference, if the decision is supported on appeal, no patent on the septic process, either alone or in combination with other well-known processes, would hold good.

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The appointment of an Inland Waterways Commission by President Roosevelt, as noted at length in our issue of March 21, was an action far broader in scope than the title of the Commission, and than most of the public comment yet made upon it, would indicate. It is true that the appointment of the Commission was due to the persistence of the advocates of improved navigation for the Mississippi Valley, and that the primary work of the Commission will have to do with inland navigation and closely allied subjects. It is also true, we may say in passing, that the appointment of the Commission was one of the shrewdest moves ever made by President Roosevelt, or any other president for that matter, in view of the attempts of some of the leading railway men of the country to make out that governmental and general public agitation of railway questions is making it impossible for the railways to meet the transportation needs of the country. But with the transportation phases of this matter we do not at present wish to deal. What we do wish to call attention to is the proposal to have made a broad and comprehensive study of the natural water resources of the United States in their relation to not one interest or set of interests alone, but in relation to all the many and varied uses for which water is in such urgent demand. These include, besides navigation, water power, irrigation (in the West), flood control, the washing of fertile top soils into the streams and the sea, and numerous minor but important subjects. Water conservation, including as it does forestry and water storage, is in itself a great problem and one which as yet has scarcely more than begun to receive attention in the United States. It is not to be expected that the Commission will be able to deal adequately with all these great subjects within any brief period of time. It is to be noted, however, that President Roosevelt contemplates adding consulting members to the Commission as soon as the work of organization and planning has progressed sufficiently to warrant such action. Particular attention may be called, in conclusion, to the composition of the Commission, which, through its inclusion of Congressmen and heads of various important governmental departments at Washington, is well calculated to give needed consideration to all phases of the great subject which has been referred to the Commission.

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It is time that those who desire to do really effective work in the prevention or amelioration of water pollution in the vicinity of New York City should stop some of the flow of arrant nonsense that has been going on for several months past and begin discussing the problem in the light of facts and of scientific possibilities. So immense and complex a problem as is presented by the sewage disposal of the metropolitan districts of New York and New Jersey will never be solved by such ignorant utterances as many of those purporting to come from a committee of the Merchants' Association of New York. These utterances are a discredit to an association that has done a large amount of valuable work for the community, and as many of them are like the cry of "Wolf, wolf!" in the old fable they will in the long run lessen the serious attention that should be given to the water pollution problem. For some weeks, at least, after these utterances began, no meeting of the Merchants' Association committee had been held, if indeed the committee has yet met for organization. The member of the committee who knew most about water pollution matters, if indeed more than one member had other than a smattering of knowledge of the subject, tendered his resignation some weeks ago, and yet his name is appearing from time to time in the interviews given out as coming from the committee. One of the silliest of the statements purporting to come from the committee, and one which has been repeated in one form or another a number of times, is the assertion that the sewage of the Passaic Valley district can readily be disposed of on the Jersey meadows, thus rendering productive large areas of land now useless. From other sources than the Merchants' Association there have recently appeared a number of ridiculous statements in which the Scranton and other recent typhoid epidemics are held up as horrible examples of what may befall New York if the sewage of the Bronx Valley is diverted into the Hudson River at or near Yonkers. One newspaper has even gone so far as to refer to the three or four cases of typhoid fever at Katonah (mentioned editorially in our issue of March 21) as warnings against the pollution of the waters adjoining New York City. In these references to Scranton and Katonah the fact is quite overlooked that no questions of water supply are involved in the discharge of the sewage of Greater New York, or of the proposed trunk sewers for either the Passaic or the Bronx Valley, into the tidal waters surrounding New York City. The long and short of it is that the whole sewage disposal problem for metropolitan New York and New Jersey is a subject which needs the earnest consideration of trained technical men and cannot be settled off hand by self-appointed public agitators. A commission or series of commissions has been in existence for several years, the special object of which has been to study the pollution of the waters of New York Bay and vicinity. In addition, water pollution matters throughout the State are being considered by both the State Department of Health and the State Water Supply Commission. If progress rather than notoriety is desired by water pollution agitators, they should stop their ignorant and misleading utterances and seek to strengthen and unify the forces already seeking to conserve the purity of the natural waters of the State. If the creation of public sentiment against water pollution is desired, let it proceed along intelligent lines, and while avoiding technicalities let it be in accordance with scientific facts and financial feasibilities.

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It costs $20 to $40 per mile per annum to maintain the roads of Colorado. It costs from $650 to $800 and over per mile per annum to maintain the main roads of Yorkshire County, England. Of course there is an enormous difference between the highways of the two localities, and the English highway would be as much out of place on Colorado plains and mountains as the Colorado road would be in Yorkshire. Nevertheless the contrast between the expenditure in the two localities has a certain interest.

The figures for Colorado are taken from a bulletin issued by the State Agricultural Experiment Station and we quote the detailed statement as follows:

> There are 9,226 miles of county road in the 27 counties which furnished complete reports. This does not include the many miles of private road, which in time will all be taken over by the state or counties. Figuring from this as a basis, the total mileage of county roads in the entire State is, in round numbers, 20,000 miles. Add to this the mileage of private roads, and some conception may be had of the tremendous mileage Colorado's road system represents.
>
> Taking the 27 counties making complete reports to this office, we find an expenditure:
>
> In 1900 of $203,918.19, which means.....$22.12 per mile.
> In 1901 of 217,118.68, which means..... 23.53 per mile.
> In 1902 of 259,437.30, which means..... 28.14 per mile.
> In 1903 of 282,229.79, which means..... 30.59 per mile.
> In 1904 of 319,826.73, which means..... 34.67 per mile.
> In 1905 of 375,003.51, which means..... 40.64 per mile.

The English figures are contained in a report by U. S. Consul Walter C. Hamm of Hull, from which we make the following quotation:

> The roads were well constructed originally and are well cared for now. It is a rare sight to see a rutty or muddy country road in this neighborhood. Most all of them are macadamized, well-drained, and kept in good repair. As a consequence one horse can draw a load which would require two or three horses over the usual country road in America. The following table gives the total expenditure for each year, the total length of roads in the district considered, and the average cost per mile for twelve years past. The pound sterling is estimated at $5:

Year.	Total cost.	Miles.	Cost per mile.
1895	$734,270	1,122	$654.42
1896	741,925	1,122	661.11
1897	787,940	1,122	702.20
1898	826,120	1,125	735.20
1899	812,850	1,128	729.47
1900	766,765	1,133	767.70
1901	789,295	1,111	710.44
1902	793,950	1,107	717.20
1903	796,990	1,104	721.91
1904	839,160	1,094	767.05
1905	879,320	1,094	803.76
1906	910,750	1,094	832.50

> As will be seen, there is a constant tendency to increase in the cost of maintenance, but this increase is, in part, accounted for by the construction of footpaths and the placing of granite "setts" to protect the roads from injury by trolley lines.

The Colorado statistician estimates that the expenditures of the entire State for road maintenance were about $813,000 in 1905; and it will be seen that this was actually less than the single county of Yorkshire expended in maintaining its highways in the same year.

Moreover the average cost of labor in Colorado is probably twice or thrice its cost in Yorkshire, so the cost of maintaining a mile of the Yorkshire road in Colorado would be twice or thrice as great. It would be interesting, if traffic statistics were available, to show the contrast between the typical road in the two localities in this respect. It may safely be assumed, however, that while the average labor expended per mile on the Yorkshire road is probably at least 50 times that on a typical Colorado mile, the traffic is very likely a hundred times as much.

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On the subject of the commercial feasibility of electric trunk line operation, the clearest and most definite statement from a source which, because of excellent information, may be regarded as authoritative was made by Mr. George Gibbs two weeks ago in the course of a discussion before the New York Railroad Club. Mr. Gibbs, besides having the advantage of many years' experience in steam railroad work, was connected with the design of the equipment of the New York Rapid Transit Subway, was engineer for the Long Island R. R. in its electric terminal installation, and is on the expert commissions of the Pennsylvania R. R. and the New York Central & Hudson River R. R. in their terminal improvements at New York City, both of which are based on electric operation. His statement may therefore be presumed to have as a foundation a thorough knowledge of railway operating conditions, accurate information on the cost of electric equipment, and figures of operating cost from actual working experience. It might be expected, moreover, that his connection with the pioneer improvements mentioned would endow him with enthusiasm and optimistic hope for electric main-line railway service; it is reasonably certain at least that his views are not darkened by pessimism in this regard. We are therefore bound to accept with great consideration his opinion that electric equipment and operation of trunk lines is of almost prohibitive cost. He says:

> In adopting electricity, at heavy cost, we must secure operating savings at least sufficient to offset interest and depreciation charges on the added investment. It has been proven that for a reasonably dense train movement (say suburban) the total cost, including general expense, but *not capital charges*, per car-mile of passenger movement will be less for electric than for steam power, for *very* dense movement substantially less. But in average trunk-line work, both freight and passenger, it will be found that, in handling a *given traffic*, electric operation cannot be made to effect enough saving—not nearly enough to offset the added charges. This deduction may be taken as of universal application under existing conditions.

These words flatly contradict numerous alluring estimates of cost and earnings which have been made from time to time by men of strongly-developed sympathies for electric operation. Indeed, Mr. Gibbs says that the cost of "conversion" has almost invariably been underestimated, and this largely because the accessory expenses have been left out of view. He adds:

> Electric apparatus cannot be supplied to an established steam railroad without many changes in its physcial features and equipment. These changes amount, in some cases, to a virtual rebuilding of the line, and, according to my experience, the electric items making up the equipment of a steam railroad under average conditions are from one-half to two-thirds of the total cost only. * * To the few railway men who have had occasion to inquire into the matter, the figures have appeared staggering.

This last statement, of course, holds true without limitation. But the statement as to operating cost, it must be noted, is made for "handling a given traffic," and depends vitally upon the possibility of developing additional traffic by more frequent service, or developing greater capacity by the larger hauling capacity of the electric motive-power or by associated improvements in operating conditions. In fact, Mr. Gibbs says that electric operation has many opportunities in (1) terminal and suburban service, especially where tunnels or the like are involved, and (2) mountain grade work, where the large reserve power-capacity of suitable electric equipment enables the maximum train load to be hauled over the grade without dividing trains.

Special insistence on the above-quoted statements as to initial and operating cost is necessary because there has been so much loose talk and so much superficial estimating, in praise of the cheapness of electric railroad operation. Clearly, if we may believe Mr. Gibbs, electric equipment is anything but advisable if the whole question were one of cost. The advisability must be proven on other grounds, on feasibility of service, ease of running frequent short trains, great range of grades permissible against multiple-unit (passenger) traffic, and the like. That a thorough-going change in system of operation is required to bring out the full value of these potential advantages is easily seen. But we have yet to learn of any detailed study of operating system, any investigation showing what is feasible and what is economical in the rearrangement of traffic to suit electric operation, especially in the general case of mixed local and through passenger and freight traffic on a single or double-track line.

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SWITCH-CLOSING DEVICES AND SWITCH PROTECTION ON MAIN TRACKS.

Railway accidents in which the condition of the track structure plays a contributing part are not rare, although less numerous than those in which defects in operating conditions and discipline are the primary cause.

During the past few weeks accidents due to defective track have been brought into unusual prominence by a series of derailments on important railways. These particular accidents have directed attention principally to the desirability of a general improvement in the construction and maintenance of track on heavy main lines in order to bring it into (and keep it in) proper relation with the character of the traffic which is imposed upon it. This is undoubtedly a matter that calls for very careful consideration at this time, but there are certain features of the track, however, which are weak points in themselves, irrespective of traffic conditions.

One of these features is the main track switch, as ordinarily applied at sidings and yard entrances. The old stub switch has practically disappeared from main track service, the construction of the split switch has been improved and strengthened materially, and some roads have taken important steps in reducing the number of facing switches on double-track lines. The great majority of main-line railway mileage is single track, so that facing switches must necessarily exist, but it is in regard to safety in operation rather than as a track appliance that the ordinary switch is a weak point.

The development in the use of block signals and interlocking plants during recent years has been very extensive. But in spite of this, on railways of both light and heavy traffic, trains of all classes are daily run against facing switches fitted simply with a common hand-lever switchstand locked with a common padlock, and having no warning device beyond a lamp and target on the switchstand. During 1906 there were reported 55 accidents where a train ran through an open switch and collided with a train on the siding, or was derailed on the turnout; in these accidents 65 persons were killed and 303 injured. There were undoubtedly many more accidents which were not sufficiently important to be reported. The disaster due to an open switch of the class above noted in the face of the "18-hour flyer" on the Lake Shore & Michigan Southern Ry., near Cleveland, O., in 1905, was a sharp reminder of the risks run and chances taken daily even by high-class trains on high class railways. The open or misplaced switch, however, causes accidents to trains of all kinds on railways of all classes, with light as well as with heavy traffic. The loss of life and property in a single accident of this kind, with a passenger or freight train running even at moderate speed, may easily be great enough to warrant considerable expenditures for the double purpose of preventing the switch being left open and of warning the engineman of an open or obstructed switch.

This state of affairs has led inventors to the design of switch-closing devices operated by main-track trains approaching the turnout, and intended to automatically close switches which may have been left standing open in the face of such a train. Such devices have recently been experimented with on two or three railways, although certainly not with any view to their adoption, and indeed they introduce new dangers in themselves. It may be said most emphatically that however perfect such devices may be mechanically, their use is based upon an erroneous idea, for which, however, the railways are largely responsible from their very general failure to equip main-line switches with the protective apparatus which should be provided. The purpose of the switch-closing apparatus mentioned is to prevent accident in the event of the failure of a brakeman or switchman to set a switch for the main track after opening it to allow a train to enter the siding. The idea that trains (whether of low or high speed) may be properly or safely run against facing switches under the protection afforded by automatic switch-closing devices of this kind is certainly not consistent with good railway practice. But in view of the fact already noted, that many trains each day run against facing switches which have not even this protection, it is not difficult to realize that many an inventor or railway employee sees a great field open for an automatic switch-closing device by which a train may protect itself.

There is, however, another class of switch-closing device which is not inconsistent with the principles of railway operation and which has a certain legitimate field of application as auxiliary to other apparatus. The devices of this class provide for the automatic closing of the switch by the train which has entered the siding, and some of them have been tried experimentally. In purpose and principle they differ materially from those of the class first mentioned. The principle is the closing of a switch behind a train, so as to keep the switch normally set closed for the main track and to prevent it from being left open carelessly. In the previous case, however, the switch may be left open, but in the emergency of a main-line train approaching it in this position as a facing switch, it would be automatically closed in the face of the train by means of a device operated by the train itself. The one is a safety device to prevent the dangerous condition of an open switch in a main track. The other permits this dangerous condition to exist, but provides an emergency device to remove it when danger is imminent. Apart from the fact that the latter is inconsistent with proper principles of railway operation, as already stated, the difference between the safety device and the emergency device is obvious.

Safety switch devices to prevent switches from being left open were tried many years ago, but were either unreliable or in other ways unsatisfactory. The earliest form was the drop-lever switchstand, having a weighted lever to return the switch rails to the closed or main-track position as soon as released. The brakeman, however, soon learned to save his time and muscle by propping up the lever with a stick, and of course not infrequently forgot to remove the stick. Another device was a cabin or "doghouse" enclosing the switchstand, so arranged that a man could not open the switch without going into the house and could not then get out as long as the lever was in position for an open switch. This was tried many years ago both in this country and abroad.

The devices which have already been given an experimental trial on two or three different railways, as mentioned in our opening remarks, belong to the "emergency" class devices, which provide for closing the switch by the approaching main-line train instead of by the retreating train on the sidetrack. In most of the devices of this sort, the mechanism is entirely too complicated or in other ways impracticable to be considered for actual use, and many of them embody the serious objection of having a spring connection to the switchrod, while modern practice is decidedly in favor of a rigid connection between switch, switchrod and switchstand. This objection is eliminated in some cases by utilizing the spring connection only at the instant of automatically closing the switch, the connection with the switchstand being rigid at all other times, whether in opening or closing. If the track device struck by the engine operates the switch directly, through the medium of rods, etc., the apparatus would be liable to injury when operated by trains running at high speed, but if this track device simply trips the operating spring this objection need not apply. Of course provision is made for trains taking the siding, as by waiting to open the switch until the engine has passed the trip, the train normally coming almost to a stop to enable the brakeman to run ahead and open the switch. It is a comparatively easy matter to design an automatic switch-closing device which will be as simple and reliable as a spring-rail frog, but as already stated, there are fundamental objections to the use of devices of this kind.

With these devices excluded, we have to consider the general question of the protection of trains at turnouts. The use of the common switchstand operated by the trainmen and unprovided with any safeguard should not be permitted at main-track switches; and the more important the traffic the more important becomes the application of this principle. All main-track turnouts on lines with important traffic, but not having block signals, should be equipped with interlocking switch and signal plant (including distant signals), and controlled by an operator in a tower instead of being operated by the train men. Where the traffic does not appear to warrant this expense, the switch should be provided with a distant signal, automatically operated by mechanical or electrical connections from the switch or switchstand, so as to give an engineman warning of an open switch at a sufficient distance to enable him to bring his train to a stop or at least reduce speed before reaching the point of danger. It is true that there is a large number of accidents due to the failure of enginemen to see or obey signals, and it has been suggested that a switch-closing device might be used as an additional safeguard. An auxiliary device to automatically apply the brakes on a train passing a "stop" signal would be, however, much more consistent with operating principles than a device to close the switch, especially as the "stop" signal might be displayed to protect a train that had not cleared the switch. In such case, the switch-closing device would not prevent collision.

In connection with this question of switch protection it is important to note that the Committee on Track, of the American Railway Engineering and Maintenance of Way Association, in its report presented at the annual meeting in Chicago, March 19-21, recommends that where trains run at over 30 miles an hour, main-track turnouts should be equipped with distant signals and facing-point locks. Their recommendation was not adopted, for the reason that while it applied to switches on track not having block signals or interlocking, it involved apparatus similar to that employed at interlocking plants. It was considered that this might be misleading, and the matter was therefore referred back to the committee for further consideration, with instructions to confer with the Committee on Signaling and Interlocking. The general principles for switch protection were not questioned, and the recommendation as presented was as follows:

> For railways where speed exceeds 30 miles per hour, main track turnouts should be equipped with semaphore type of switchstands with distant signal, reinforced switch points, facing-point lock, and reinforced spring-rail frog; also, upon sidings where cars are allowed to stand and upon passing sidings with a derail to operate in connection with main track switchstand.
>
> The type of switchstand for facing-point switches as recommended is intended to correspond with the practice of interlocking signals; upper arm governing main track routes and lower arm governing side track routes, and is for switches where interlocking has not been established. At points where the speed of trains is greater than 45 miles per hour, the committee thinks it impracticable to operate wire-connected or pipe-connected distant signals, and would prefer at such points distant signals of the electric type.
>
> Main track switchstands should have the following parallel throw: There should be two levers, one to operate the facing-point lock and the second to operate the switch. These two levers to be so arranged that it will be impossible to get clear signal for the main track unless the switch is locked for the main track.

Where the automatic block signal system is in use, of course, a train approaching an open switch would be warned by one or more signals, but this system is in use on only a very small percentage of the vast mileage of main-line railways. There are, however, numerous devices for automatically operating mechanical or electrical distant signals from the switchstand, some of which have been described in our columns. Several railways are using protective appliances of this kind, as was shown in an abstract of a paper in our issue of Sept. 21, 1905, but unfortunately neither these appliances, switch interlocking plants, nor block signal systems are in use to anything like an extent commensurate with the requirements for the safe handling of traffic under modern conditions of railway service.

While accidents due to misplaced switches are far too numerous, it may safely be said that the use of automatic switch-closing devices operated by approaching trains is not the proper remedy, for reasons above given. There does, however, seem to be a certain field for a device which will automatically close a switch behind the inferior train taking the side track, instead of in the face of a train approaching on the main track.

In conclusion it may be said that this matter has nothing to do with the question of high speed, except that the severity of accidents will of course be in some proportion to the speed. The question is that of the protection of the regular traffic, whether passenger or freight, and not simply that of protecting fast trains. The most effective remedy for the existing troubles is to adopt the block-signal system and to take the handling of the switches out of the hands of the trainmen. For lines where these steps cannot be taken, there is a remedy in the use of automatic distant signals at switches, with switch locking apparatus, and perhaps also with an auxiliary in the form of a device to keep the switch set for the main track except when in actual use to admit a train to the side track.

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LETTERS TO THE EDITOR.

Cracks in U-Abutments.

Sir: Referring to the query of D. E. W. in your issue of March 7, I have noticed that it is quite common for cracks to develop near the angles in monolithic concrete bridge abutments, either in the wing near its junction with the abutment wall or in the wall itself. In fact, I don't think I ever saw a U-abutment, not reinforced in the angle, which was free from these cracks. I have always attributed such cracks to shrinkage, and such abutments of this type as I have built have been reinforced by several steel rods in the angles. When my attention was first attracted to these cracks in concrete abutments I was disposed to attribute them to unequal settlement of different parts of the foundation, but closer observation showed that abutments whose foundations could not be questioned had these same cracks.

Very truly,

Joseph Wright,
Engineer, U. S. Reclamation Service.

Corbett, Wyoming, March 12, 1907.

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Natural Cements.

Sir: I wish that you would kindly inform me through your columns why it is that the average engineer will condemn a "natural" cement that is competent to develop both the tensile and compressive strains called for, by the "American Standards" of testing materials, for an artificial cement. It also shows no signs of contraction or expansion under the tests for soundness. The only test to which it will not conform is the "specific gravity" test, but as that is used for the sole purpose of discovering adulterations, it should not make a material difference. This cement is guaranteed by the manufacturers to develop 400 lbs. per sq. in. tensile strength, in seven days (neat test), and their guarantee is reliable.

Yours respectfully,

W. J. H. Payne.

Maritime Building, San Francisco, Cal., March 11, 1907.

[The prejudices against most "natural" cement are due to its usual lack of uniformity, its very quick-setting properties, and its low strength both in tension and compression. (Specification —100-200 lbs. per sq. in. in tension, 7-day test.) In certain kinds of work these defects are of a lesser importance and, on account of reduced cost, the natural cement is often used.—Ed.]

Engineer's Estimates for Partial Payments.

Sir: In reply to "A Subscriber" from Lavina, Montana, in your issue for March 14, 1907, in regard to the giving out the quantities on partial estimates to the contractor, there are sufficient reasons, I think, for not doing this at the time of computing the quantities nor afterwards.

(1) It is not customary, to my knowledge, upon 14 railway systems, and I presume not authorized on any.

(2) It is not good practice, for the reason that it either places the resident engineer in an embarrassing position before the contractor, in case the division engineer sees fit to interpret differently the classification or method of computing of even correctly measured quantities, or it seriously handicaps the division engineer in the execution of his rightful authority in case he wishes to exculpate his resident engineer and save explanations. On most systems it is not allowed by strict orders for the above reasons, but even should the superior allow it without exactly ordering it, there still remains the fact that it precludes justifiable corrections. I was at one time a witness in a suit where the subcontractor claimed damages on account of certain supposed or anticipated profits being cut out, due to changes in estimating and classifying material in a large cut. He set up a claim, and a good one, too, that he had gone far beyond his means in buying machinery, a thing he would not have done had he known the resident engineer's classification was not correct, authentic and conclusive.

(3) An engineer's superior officer in all cases is alone entitled to the information contained in his reports, and if there is urgent need of this information by the contractor it can usually be obtained from the proper officer in ample time for him to make his financial arrangements and outlay. Fairness to the contractor, of course, would countenance no unnecessary delay by the Chief Engineer.

Very truly,

Ray S. Blinn.

Mount Vernon, O., March 16, 1907.

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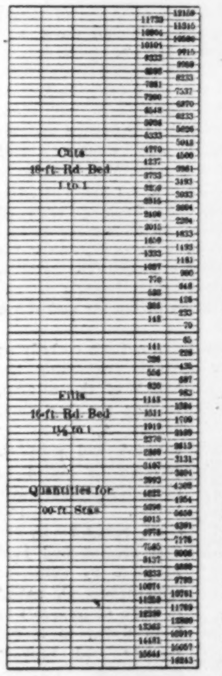
A Method of Scaling Earthwork Quantities from a Profile.

Sir: Referring to the letter of Mr. W. E. Davis, in your issue of Feb. 28, in regard to the "quantity scale" for estimating earthwork quantities, on railroad construction, from the profiles of the line:

The idea is by no means new, though it is not as commonly used as it should be. It was pointed out by the writer in a recent paper (Trans. Am. Soc. C. E., Vol. LIV., p. 104) and also in his book on "Railroad Location"; the figure reproduced herewith was used in each instance.



It should be noted that it is much more convenient to have the quantities increase downward from the zero, for fills, and upward for cuts, as shown in the figure, as by this means the zero always follows the grade line. The scale shown in the drawing accompanying Mr. Davis' letter is all right for fills, but if used for cuts the zero would have to follow the ground line, instead of the grade line, which is not quite as convenient, though giving the same results.

Two or three of these scales should be prepared at the beginning of the survey for the widths of roadbed to be used, for slopes of ¼ to 1, ½ to 1, and 1 to 1 for cuts, and 1½ to 1 for fills. It will be found that they will not only save an immense amount of time in taking off the quantities, but also give results within 10% of the cross-section on quantities if properly used.

There is no need of using formulas with Greek letters for calculating quantities of level cuttings, as there are plenty of tables for various widths of roadbeds already calculated, and it is only a matter of simple arithmetic to calculate them if the tables are not available. Greek letter formulas have their place, but it is not necessary to use them just because one knows how. As for transverse slopes, when they are steep enough to affect the quantities beyond the limits of the other unknown factors which enter into the making of estimates, the writer has found the quickest and most satisfactory way to be to take off a few three-level sections at these points from the topographical map and figure them in the ordinary manner by plain arithmetic, as pointed out in a previous communication to your paper on that subject.

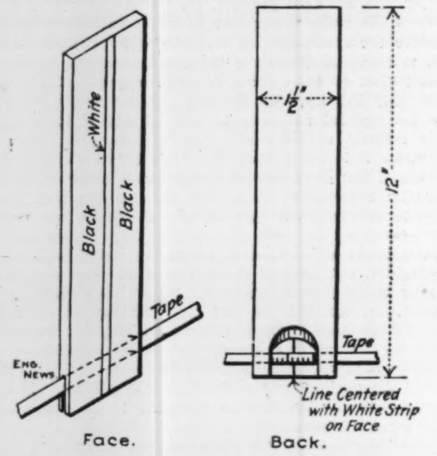
Yours very truly,

F. Lavis.

42 South 10th Ave., Mt. Vernon, N. Y., Feb. 28, 1907.

A Device for Long-Distance Tape Reading.

Sir: I notice in your issue of Jan. 24 an interesting communication from Mr. Wm. MacDonald on a method of locating property corners by swinging rectangular co-ordinates from the transit line. This is the same method that I use in locating street corners. For the purpose of taking these ordinates I use a little device, a sketch of which accompanies this letter. As indicated by the sketch, this device fits over the tape and slides along it, and when properly set is clamped by the thumb and the distance read. This device enables one to take right angle ordinates from the transit line at a distance of five or six hundred feet with great accuracy and convenience.



Yours very truly, Jno. H. Ferguson,
Assistant City Engineer, Augusta, Ga.
Feb. 14, 1907.

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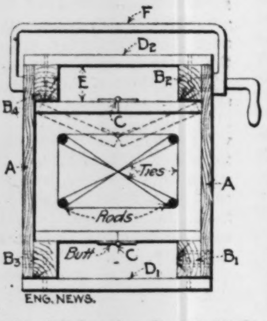
A Detachable Concrete Column Form.

Sir: When building reinforced concrete columns, having flexure rods united at intervals by ties, forms are often used having one side open, which is built up in sections as the concrete is deposited. These forms usually consist of four or more uprights enclosed on three sides, the fourth being open to allow access to the interior, and closed as the work proceeds by horizontal boards nailed to the uprights. Through the open side all the operations of depositing, spading and tying are conducted.

Two improvements to this device suggest themselves. First: The work of erection will be greatly facilitated if two opposite sides can be conveniently left open. Second: The placing of concrete will be expedited and depreciation of forms lessened if the open sides be closed without nailing. The closing pieces must fit snugly to avoid ragged corners or distortion of the column section, and be inserted without driving, and the construction of parts must be neat, and be carried on during concreting. The insertion must be made by the laborers depositing the concrete, directly and without loss of time. The removal of the form must be accomplished by the forcible detachment of few pieces, to prevent waste of lumber and shock to the concrete.

The accompanying sketch illustrates a form embodying these suggestions: B_1—B_4 are uprights, extending the length of the column, leaving the horizontal boards A, preferably tongued and grooved, permanently nailed to them throughout their height. These two sides, ready made, are first erected and held in place by sufficient cross-braces D, nailed to them at intervals of 3 to 6 ft., to insure rigidity and prevent subsequent bulging. The reinforcement having been placed, horizontal boards, C, cut to fit, are inserted, and the concreting begun. These boards are hinged at the center with one or more butts, permitting them to bend inward as indicated by the dotted outline, when they can be set snugly in place and without encountering the reinforcement. The top and bottom edges of these boards may be tongued and grooved to prevent leakage, but only a butt joint is required at the hinge, where a tight joint is insured by the compression of the inner edge.



The concreting and tying is conducted from both sides, the boards C being placed as the work proceeds and holds firmly against the uprights by the concrete.

To remove the form, the cross-braces D are knocked off, when the whole comes apart and is again ready for use with the minimum of depreciation. It will be noted that the parts to be forcibly removed are few, and can be quickly disengaged with little shock to the concrete. The substitution of clamps F, and, if necessary, struts at E for the cross-braces, entirely removes these difficulties. When it is desired to chamfer the column corners, the usual triangular pieces may be fastened to and form a part of the boards C.

The butts may, of course, be used many times, both on the original and subsequent forms, and their cost becomes negligible when so considered. They should be fairly heavy, and the boards not less than 2 inches thick for a column diameter of 15 ins. or more.

Yours truly, Waldo S. Coulter,
Asst. Engr., N. Y. State Barge Canal.
Albany, N. Y., March 11, 1907.

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Tables for Roadmasters.

Sir: Please note the accompanying tables which I prepared some time ago for the use of roadmasters. The table of chord offsets (Table I.) seems to be appreciated by them in roughly going over propositions for tracks, particularly at outlying points where it seems hardly worth while to send an engineer to make a survey, when the parties to be served by the track expect to do the grading themselves. A careful man can secure very fair results with this table which he would not ordinarily be able to do. Roadmasters also I find have been having difficulty in cutting their rails on curves in many places, it being necessary for foremen to lay the track around to the end of the curve, keeping their joints about where he thinks they should be and cutting the rail to fit when he gets to the end of the curve. With a large extra gang and many curves in the track, it is of great advantage if the roadmaster can give to the extra gang foreman who is relaying the steel the exact cuts on all the curves, and seems to facilitate the work considerably.

You perhaps have published similar tables to these, but I have not seen any in recent years. If you think these tables worth it, I would be glad to have you print them for the benefit they may be to maintenance engineers who would no doubt have a copy made for their roadmasters where they would hardly go to the trouble of making them up in the first place.

Yours truly, W. W. Gaffin,
Division Engineer.
Chicago & Northwestern Ry. Co., North Fond du Lac,
Wis., March 7, 1907.

TRANSVERSE CONTOURS FOR ROADWAY PAVEMENTS.

General Equation, $y = \frac{x^2}{l^2} nd + \frac{x}{l} (1 - n) d$

Tables Showing Values of y in Terms of d for Different Values of n.

x =	1/6 l	2/6 l	3/6 l	4/6 l	5/6 l
n = 1/4	.132	.278	.438	.611	.799
1/3	.120	.259	.417	.593	.787
1/2	.097	.222	.375	.555	.764
2/3	.074	.185	.333	.518	.741
3/4	.062	.167	.313	.500	.728

x =	1/8 l	2/8 l	3/8 l	4/8 l	5/8 l	6/8 l	7/8 l
n = 1/4	.098	.203	.316	.438	.566	.703	.848
1/3	.089	.188	.297	.417	.547	.687	.838
1/2	.070	.156	.258	.375	.508	.656	.820
2/3	.052	.125	.219	.333	.468	.625	.802
3/4	.043	.109	.199	.312	.449	.609	.792

x =	.1 l	.2 l	.3 l	.4 l	.5 l	.6 l	.7 l	.8 l	.9 l
n = 1/4	.078	.160	.248	.340	.438	.540	.648	.760	.878
1/3	.070	.147	.230	.320	.417	.520	.630	.747	.870
1/2	.055	.120	.195	.280	.375	.480	.595	.720	.855
2/3	.040	.093	.160	.240	.333	.440	.560	.693	.840
3/4	.033	.080	.143	.220	.313	.420	.543	.680	.833

x =	.1 l	.2 l	.3 l	.4 l	.5 l	.6 l	.7 l	.8 l	.9 l
n = .1	.091	.184	.279	.376	.475	.576	.679	.784	.891
.2	.082	.168	.258	.352	.450	.551	.658	.768	.882
.3	.073	.152	.237	.328	.425	.528	.637	.752	.873
.4	.064	.136	.216	.304	.400	.504	.616	.736	.864
.5	.055	.120	.195	.280	.375	.480	.595	.720	.855
.6	.046	.104	.174	.256	.350	.456	.574	.704	.846
.7	.037	.088	.153	.232	.325	.432	.553	.688	.837
.8	.028	.072	.132	.208	.300	.408	.532	.672	.828
.9	.019	.056	.111	.184	.275	.384	.511	.656	.819

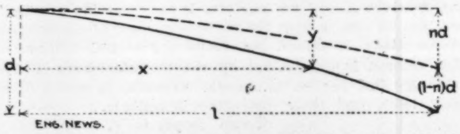

TABLE I.—TABLE OF CHORD OFFSETS FOR ROADMASTERS.

Degree.	Offset for 50 ft. chord.	Offset for 100 ft. chord.	Degree.	Offset for 50 ft. chord.	Offset for 100 ft. chord.
0° 30′	0.2	0.9	6° 0′	2.6	10.5
1° 0′	0.4	1.7	7° 0′	3.0	12.2
1° 30′	0.6	2.6	8° 0′	3.5	13.9
2° 0′	0.9	3.5	9° 0′	3.9	15.6
2° 30′	1.1	4.4	10° 0′	4.4	17.3
3° 0′	1.3	5.2	12° 0	5.2	20.8
3° 30′	1.5	6.1	14° 0′	6.1	24.2
4° 0′	1.7	7.0	16° 0′	7.0	...
4° 30	2.0	7.8	18° 0	7.8	...
5° 0′	2.2	8.7	20° 0′	8.7	...
5° 30	2.4	9.6			

TABLE II.—SHOWING DIFFERENCE IN LENGTH OF OUTSIDE AND INSIDE RAILS ON CURVES FOR 100-FT. LENGTHS.

Degree of curve.	Difference for 100 ft. in ins.	Degree of curve.	Difference for 100 ft. in ins.
0° 15′	.2465	4° 30′	4374
0° 30′	.4930	5° 0′	306
0° 45′	.7396	5° 30′	235
1° 0′	.9861	6° 0′	166
1° 30′	1.4791	7° 0′	027
2° 0′	1.9722	8° 0′	888
2° 30′	2.4652	9° 0′	749
3° 0′	2.9583	10° 0′	611
3° 30′	3.4513	11° 0′	471
4° 0′	3.9444	12° 0′	333

Example: 3° 30′ curve 615 ft. long. 3.4513 × 6.15 = 21.25 in. = 21¼ ins.

[These figures have been published in the same or similar form in text-books and also in the technical press; but for the immediate benefit of roadmasters who may not have them at hand we reproduce them herewith.—Ed.]

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Notes and Queries.

A wooden ware firm, of Massachusetts, writes:

> We are about to construct a two-story dry kiln with two kilns 15 by 60 ft. on each floor. Can you give us any information as to the use of concrete for such purposes or can you put us in touch with some firm that have used reinforced concrete or concrete blocks for dry kiln construction? The kilns are to be used for drying pine lumber.

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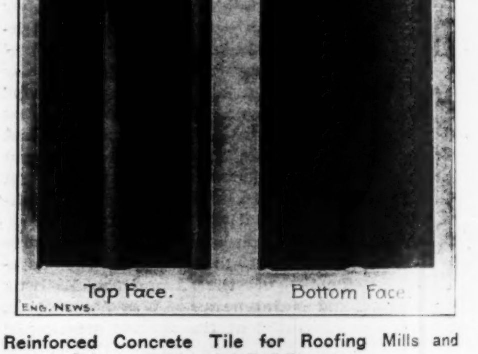
CONCRETE TILE ROOFING FOR MILLS AND INDUSTRIAL BUILDINGS.

A roofing material that is durable, easily laid, and economical in both first cost and maintenance, is a great desideratum for buildings such as steel mills, factories, freight stations, power houses, etc. An interesting development in roofing for structures of this class is the use of reinforced concrete tiles of large size. Small tile or shingles of concrete have been used for residences, etc. (Eng. News, Aug. 30, 1906), but the tile above referred to are 52 × 26 ins. in size, with a weather surface of 48 × 24 ins. (12½ pieces to a square of 100 ft.). They are not affected by smoke or gases and require no nails, wires or other fastenings, while sheathing of any kind is also unnecessary. At the same time the steel framework for the roof is much simplified; thus with roof trusses 20 ft. apart, no rafters are required and the purlins may be 8-in. channels spaced 4 ft. apart.



Reinforced Concrete Tile for Roofing Mills and Industrial Buildings.

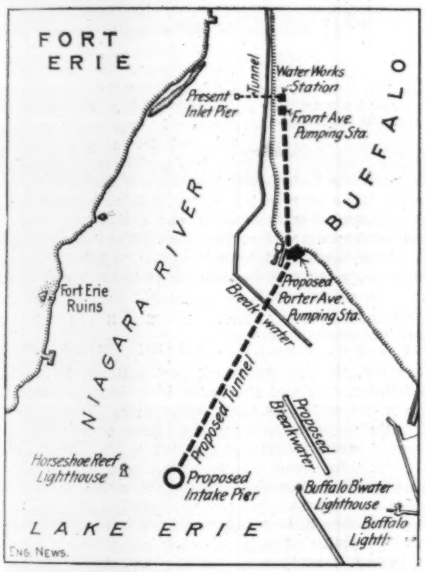
The tiles have projections by which they are hooked to the purlins, they are laid in place by their own weight, and will not be displaced even by very high winds. The minimum slope of roof is a 1 to 6 pitch. The interlocking side joints, 2 ft. apart, have ¼-in. play and allow for expansion and contraction longitudinally of the roof, while the 4-in. end lap at top and bottom provides for any up and down movement. The weight is about 13 lbs. per sq. ft. and the safe carrying load is 150 lbs. per sq. ft., while the breaking load is 250 lbs. per sq. ft. The form of the plain tile is shown in the accompanying cut, but the end tiles are of L shape, with a flange projecting down over the wall; special ridge-roll tiles are also made.

The tiles, as stated, are 52 × 26 ins., and are ⅞-in. thick, reinforced with a sheet of No. 18 expanded metal near the lower surface. They are made of a mixture of 1 part Portland cement and 3 parts sharp sand, made in a machine mixer and being of a medium wet consistency. They are made on steel pallets which are put in a machine by which they are thoroughly tamped. When removed from the machine, the tiles are placed in drying racks, where they remain for seven days, until thoroughly set. They are then stacked in the warehouse, being constantly sprinkled, and are left to cure from six weeks to two months before being shipped. The usual color is red, but the tiles can be made of any desired color.

Among the plants for which this roofing is being used are those of the Pittsburg Plate Glass Co., at Crystal City, Mo., and the Indiana Steel Co., at Gary, Ind.; the Chicago Bridge & Iron Works, American Bridge Co., American Locomotive Co., Western Electric Co., St. Louis Terminal Railroad Association, Toledo Furnace Co., and many others. These tiles, known by the name of the Bonanza tiles, are manufactured by the American Tile Mfg. Co., of Wampum, Pa., and the Hunkins-Willis Lime & Cement Co., St. Louis, Mo.

THE NEW INTAKE TUNNEL AND ACCESSORIES FOR THE WATER-WORKS OF BUFFALO, N. Y.

The Department of Public Works of Buffalo, N. Y., has been authorized to expend $1,272,000 for a new water-works intake pier tunnel and for four shafts on the line of the tunnel. One of the shafts will be located in the intake pier, one at the site of possible filtration works at the Bird Island pier, one at the site of a proposed new pumping station, and one at the present pumping station. The intake pier will be located in Lake Erie at the head of the Niagara River, some 1,000 ft. southeasterly of the Horse Shoe Reef Lighthouse. The bottom of the lake at this point is practically level and is 18 2-3 ft. below the mean level of the lake. Rock at this point is about 27 to 30 ft. below mean lake level, the 10 ft. of material overlying the rock being composed of sand, gravel and clay. The intake pier will be circular in plan, with an inside diameter of 70 ft. and an outside diameter of 110 ft. and with its walls composed of steel and concrete; there being an outer and inner steel sheathing, and radial walls filled between with concrete. This will rest upon a concrete ring placed by means of trip-bottom buckets and weighted canvas tops. The steel shells and 24 radial partitions will be composed of ⅜-in. steel plates, butt-jointed. At the junction of the partitions and shells will be ⅜-in. steel gusset plates. The shells and partitions will be constructed on shore, floated to place and sunk. The inlet shaft will be sunk into the rock to a depth of about 49 ft., of which 24 ft. will be to the roof of the tunnel, 12 ft. to the bottom of the tunnel, and 13 ft. farther to the bottom of a sump. The shaft will be lined with concrete about 1 ft. in thickness, and will have a finished inside diameter of 13 ft.



Sketch Map Showing Location of New Water-Works Intake Pier, Tunnel and Shafts, Buffalo, N. Y.

The Porter Ave. shaft at the site of the proposed new pumping station will be lined with concrete to the finished size of 13 ft. 1 in. by 14 ft. At the present or Massachusetts Ave. pumping station there will be a concrete-lined shaft with a size when finished of 10 × 10 ft. The filtration shaft will be double, an uptake compartment being provided for raw water and a downtake compartment for filtered water.

The inlet pier and the Porter Ave. shaft at the site of the proposed new pumping station will be connected by a tunnel about 6,500 ft. in length and 128½ sq. ft. in cross-section. The tunnel will be continued to the Massachusetts Ave. pumping station shaft, a distance of 4,000 ft., but with its cross-section reduced to 78.8 sq. ft.

The foregoing information has been taken from specifications and from a letter, both sent to this journal by Mr. Henry L. Lyon, Deputy Water Commissioner of Buffalo. Mr. Francis G. Ward is Commissioner of the Department of Public Works. Bids for the work were received on Aug. 22, 1906, and the contract was awarded to the Buffalo Dredging Co. (the lowest bidder) on Feb. 6, 1907, for the price stated at the opening of this article.

* * *

COMMITTEE REPORTS, AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.

Abstracts of some of the principal features of three of the committee reports presented at the annual meeting in Chicago on March 19 to 21 are given below. Particulars as to the general proceedings, with notes of the various reports and discussions, are given in our report of the convention proceedings on another page.

EXPERIENCE WITH TREATED TIES.

(Abstract of the Report of the Committee on Ties.)—However interesting the investigation and discussion of substitutes for wood ties may be, there can be no question but that we should make the best possible use of the wood tie while we have it. Few subjects should be of greater interest to railway officials than the question of the actual results of the preservative treatment of ties. The use of such ties is constantly and rapidly increasing and the disposition of those using them is to feel greater confidence in the results, and a greater willingness to invest more money therein. The benefits of treatment are pretty nearly proportional to the amount expended.

Pennsylvania Lines West of Pittsburg.—At Kosciusko, Ind., 200 burnettized tamarack and 200 untreated white oak ties were laid in gravel ballast, resulting in an average life of 8.8 years for the tamarack, and 9.2 years for the oaks. At Hanna, Ind., 200 burnettized hemlock and 200 untreated white oak ties were laid in rock ballast, resulting in an average life of 9.1 years and 8.4 years, respectively. Besides the above tests, which terminated two years ago, considerable numbers of ties of various kinds treated by the same method have been used; the records of results are by no means complete, but Mr. Trimble, Chief Engineer of Maintenance of Way of the Northwest System, under date of December, 1906, furnishes the following particulars of ties treated by the zinc-tannin process:

Date laid.	No. laid.	In service Jan. 1, 1906.
Burnettized beech; Western Division:		
1901	9,937	100%
1902	13,835	100%
Burnettized red oak; Western Division:		
1897	135	74%
1901	5,309	100%
Burnettized hemlock; Western Division:		
1897-98	11,393	78%
1898	713	92%
1899	2,048	100%
1900	521	100%
Burnettized hemlock; Chicago Terminal Division:		
1896	698	100%
1897	3,499	76%
1898	275	100%
1899	1,000	100%
Burnettized hemlock; S. C. & S. Ry.:		
1897	1,287	70%

Duluth & Iron Range Ry.—Under date of Oct. 19, 1906, Mr. Robert Angst, Chief Engineer, writes:

> We still have in track 45 white pines, 68 tamarack ties, 79 Norway ties. We have not taken out any of the ties since they were replaced in the track in 1895. The rail is cutting into the ties pretty badly, most of them over ½-in. Otherwise the ties are in pretty good shape. I do not think we will have to take any of them out for two or three years. These ties are on a maximum grade at the summit of a long pull, and the cutting under the 80-lb. rail has become more marked with the increased number of steel ore cars of 50 tons capacity and the putting into service of a number of 170-ton consolidation engines. These engines, like all consolidation engines, have a large unloaded space between the front axle of the tender and the rear driver, and that the uplift of the rail between these two points which travels with the locomotive, is largely to blame for this cutting, as the sharp reverse vertical curve in the rail close to the rear driver has a tendency to rock the tie or cause the rail flange to cut into the shoulder.

Chicago & Northwestern Ry.—During the spring of 1906, a few treated hemlock ties were found in the track between Mayfair and Evanston, Ill. As it was known these ties must be very old, inquiries were made to ascertain when and how they were treated. It was found the Chicago Tie Preserving Co. had treated 5,934 hemlocks and 2,393 cedars by the zinc-tannin process in the late fall of 1888. The hemlocks received 0.22-lb. and the cedars 0.48-lb. dry zinc chloride per cu. ft.*

Atchison, Topeka & Santa Fe Ry. (Lines East of Albuquerque, N. M.).—This road had laid up to Jan. 1, 1906, burnettized ties to the amount of 13,708,467. Records of removal prior to 1897 are lost, but since that time the average life of all ties removed on account of decay has been 10.62 years. Of the ties laid in 1885, 4,693 were taken out in 1904 and 4,633 in 1905. In 1905 there were laid 2,192,027 treated ties and 93,888 untreated ties.

Chicago & Eastern Illinois Ry.—This road has been using ties (principally red oaks) treated with zinc tannin since 1899, the total number laid to Jan. 1, 1906, being 1,337,413. The total number removed to the same date has been 6,118, of which 75% were taken up because of changes in track and track taken up, and were probably relaid; wrecks, 14%; burnt, 5%; the balance, 316, or 5% of the renewals were taken out as rotten, broken and for unknown causes. If all of these had come from the 1899 ties and were all removed because of decay, 94% would still be in service after six years.

The Southern Pacific Ry. continues its reports of service received from treated ties, although unfortunately those for the year ending June 30, 1906, for the Pacific System, were lost in the San Francisco fire. The report for the Atlantic System shows 34% of the ties laid in track, 14 years previously, to be still in service; 34% also of these laid 13 years previously; 46% of those in track 12 years; 58% of those 10 and 11 years; 60% of those 9 years; 84% of those 8 years; 95% of those 7 years; 96% of those 6 years; 99% of those laid later.

In 1880-1-2 there were 150,000 ties creosoted with about 10 lbs. of oil per cu. ft. and put in the tracks of the Houston & Texas Central Ry. Recently it has been found that 11,282 of these are still in service. No information is obtainable as to when the others were removed. Mr. O. Chanute has made some interesting calculations regarding these ties, assuming that those remaining have been in now 24 years and that they will all come out in two years more. By applying what he considers the characteristic curve for renewals, based largely upon European experience, extended to take in the percentage of these ties still in track, and therefrom figuring the average life of all the ties, he concludes it probable they have given an average life of 19.35 years.

We have been favored with a report by representatives of the railway on the ties in the experimental track on the Gulf, Colorado & Santa Fe, bringing the information thereon down to January, 1907. All ties were laid in May, 1902:

> Of 24 untreated black oaks, only two remain in track, and they both show decay. Of 153 treated with zinc chloride, none have come out, and only four show any decay. Of 60 treated with zinc and creosote, in two injections, all are good.
>
> Of 20 untreated willow oak ties, 15 were removed in 1905 and one of the remainder now shows decay. Of 40 treated with zinc, only one shows decay; ten treated with zinc creosote, two injections, are all good.
>
> Of 20 Spanish oaks, four are out, and seven of the remainder show bad decay. Of 41 treated with zinc, all are in good condition. The same is true of those treated with zinc creosote.
>
> Of 20 untreated turkey or yellow butt oaks, 18 were removed October, 1906, two are in track in good condition; 49 treated with zinc and with zinc creosote are all in good condition.
>
> Of 91 treated red oaks, 82 were removed in 1905, and of the balance in track all but two show decay. Of 126 treated with zinc, only four show any decay; ten treated with zinc creosote are all good.
>
> Of 197 untreated white oaks, 44 show decay. Of 401 treated with zinc, two show decay. Of 100 treated with zinc creosote, one shows decay.
>
> Of 49 untreated tamaracks, all were removed in February, 1905. Of 149 treated with zinc, and 49 with zinc creosote, none show decay.
>
> Of 100 untreated loblolly pines, all were removed in May, 1904. Of 200 treated with zinc, two show decay. Of 100 treated with zinc creosote, one shows decay. Of 80 treated with zinc and Beaumont crude oil, two were removed for decay. Of 100 immersed in spirittine, 80 were removed in 1904, 18 in 1906, and the two remaining show decay. Of 42 soaked in Beaumont crude oil for 48 hours, 40 came out in 1904, and the balance show decay.
>
> Of 93 untreated longleaf pines, 85 were removed in 1904, and of the balance, all but one show decay. Of 100 immersed in spirittine eight were removed in 1906, and of the balance, 36 show decay. Of 100 immersed for 48 hours in Beaumont crude oil, 71 were removed in 1906, and of the balance, four show decay. Of 200 treated with zinc, none were removed nor show decay. Of 100 treated with zinc creosote, and 100 with zinc and Beaumont crude oil, none show decay.
>
> Of 100 untreated shortleaf pines, all but one were out by October, 1906, and the one shows decay; of 101 un-

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*No definite records of these now exist.

> treated hemlocks, all were out by September, 1904; of 100 untreated beech, none remain; the shortleaf, hemlock and beech ties treated with zinc or zinc creosote, all remain in, and only four pines and two beeches show decay.

The A. T. & S. F. Ry. has been experimenting along various lines, especially with California crude oil heated and forced into the wood under pressure; 14 such ties were placed in the experimental track in February, 1902. These are all still in good condition. Ties boiled in zinc chloride are in equally good condition. There were 84 ties treated at Somerville, Tex., in 1905, with avenarius carbolineum, in the manner specified by the manufacturers, viz., by immersing some ties in the compound heated to between 125° F. and 150° F., and by coating or painting others with the stuff by means of a stiff brush, applying all they would absorb in this way. At present two of these ties have fungi on them and 11 others show decay. Referring further to the ties treated with the California oil, additional information is given in a letter from Mr. Faulkner, Manager of the Tie and Timber Department of the A. T. & S. F. Ry. System, as follows:

> We have been using crude oil in our engines in California since 1891, and a few years thereafter began sprinkling the roadbed with oil to keep down dust; so that a coating of oil was spread over the tops of the ties, which seemed to add to their life (they were untreated) by keeping the moisture off the tops; at all events this was the belief of the track men.
>
> In the vicinity of Bakersfield we get an oil, costing about 25 cts. per bbl. of 42 gals. of low gravity, which has an asphaltum residuum of about 77½%, the balance being mainly light oils, so that when Dr. Von Schrenk, of the Government Service, asked our people for a length of track in southeastern Texas to conduct a number of experimental tests on the different wood preservative processes then in common use, we took the opportunity of putting in a few ties of each kind of wood treated with nothing but this same crude oil, alongside the others, in order to obtain a practical comparison of the result. These were treated in the fall of 1901 and put in the track in March, 1902. Where they are laid an untreated loblolly pine tie lasts about two years, and a longleaf pine less than four years on account of heat and moisture, so that we use this piece of track for our wood preservative experiments with the surety that if a tie will last from decay down there a certain length of time, it is good for at least three times the life in other places on the system, judging by the life there of similar wood untreated.
>
> The timber experts claim that in order to produce decay, moisture and heat must be present at the same time, with access to the air. We therefore took thoroughly well air-seasoned ties, in which, of course, the cells would be more or less open, and filled them with this crude oil heated to 180° F., forced in under a pressure of 150 lbs. per sq. in.; at this temperature I am inclined to believe that a good proportion of the light oils had evaporated, leaving only the asphaltum residuum, which was then as fluid as creosote. The ties took up from 4 to 8 gals. per tie, only one taking the latter amount, and the oil appears to have hardened in the cells under atmospheric temperature, so that up to the present (five years' service) they are in first-class shape so far as preservation and wear are concerned. In November last we took one out of the track and sawed it in two in the middle and under each rail base; the wood was as sound and firm as when laid in the track, with less rail cutting than with the other treatments, the spike holding firmly, and when drawn was as bright and clean as a newly made one. We have since taken out another pine tie of a different variety, but sawed, and found on sawing it the same as before, that the wood was just as sound and firm. In one place the sawing developed a decayed place in the tie, which had taken up more oil on account of its decay. This had not spread or caused any trouble, presumably on account of the ring of oiled wood surrounding it.
>
> In this experimental track we have a number of different kinds of wood treated with different processes. They all show up well excepting one (the Hassellman), which has practically gone to pieces; and as a contrast, in each case we also have a number of the untreated woods inserted for comparison. We do not claim there are any antiseptic properties in the crude oil, but we do believe that by stopping up the open wood cells with a substance which solidifies under ordinary temperature, we prevent heat, moisture and air from getting into the wood and thereby affording an opportunity for the decay-producing organisms to begin work. This seems to be proven in our case, and as a result of the test, borne out by general experience on the divisions where oiling has been done, in the new treating plant we are preparing to erect in New Mexico, the pine ties will be treated with this same grade of crude oil forced in under from 150 to 200 lbs. pressure at a temperature of 180° F. We will probably introduce the oil under a vacuum, and at the end apply a low vacuum before drawing the ties out of the cylinder, in order that the drip may have a show. In this way the ties are reasonably clean and easily handled after treatment. I am also arranging to put in a lot more in the Texas experimental track, and sending some to the Tampico Branch of the Mexican Central Ry.
>
> The analysis of the crude oil used is as follows:
>
> | | |
> |---|---|
> | Flashes | 242° F. |
> | Burns | 300° F. |
> | Specific gravity | 0.966 |
> | Degrees Beaume | 15 ° |
> | Gasoline | Trace |
> | Illum. kerosene | 22% |
> | Sulphur | 2.41% |
> | Residuum (chiefly asphaltum) | 78% |
>
> Untreated woods were laid in the track alongside of these oil-treated ties in the early spring of 1902. The oil ties were all in first-class condition at last inspection (four years and ten months after they were laid), while of the untreated ones laid at the same time and all inspected together a majority had decayed and been removed.

The crude oil treatment by the Santa Fe Ry. will be confined to those ties treated at the new plant about to be erected at Belen, N. Mex.; bridge timber, piling and also ties treated at the other plants being creosoted as before.

This experimental track is located purposely in one of the most unfavorable places in this country to the life of a tie. The rainfall is heavy and the heat great. One of the criticisms made in the past years on the results secured with treated ties on the Southern Pacific and the Santa Fe roads, was that such results were not conclusive as to what could be expected in Illinois, Ohio or New York, because these roads ran through arid districts, where everything was favorable to the zinc treated tie. Such criticisms were justified then, but in the light of such evidence as this experimental track affords, of the increased life of the treated tie as compared with the untreated one, there can be no question of the value of such treatment. It does not yet appear what the life of the zinc-treated tie will be, but if all of the red oaks so treated come out in 1907, the two years longer life secured therefrom, as compared with the untreated tie, would pay for the cost of treatment; and there is no reason to expect them to come out for years to come. This is even more true of the pines, beeches and hemlocks. There can be little question but that for such conditions the treatment of the white oaks would be profitable, especially with creosote.

When such experimental results are supplemented by those in the large use in other roads, it would seem that the question confronting the railroad officials would not be: "Does treatment pay?" but "What treatment will pay best for this particular road?"

QUANTITY OF PURE REAGENTS REQUIRED TO REMOVE ONE POUND OF INCRUSTING OR CORROSIVE MATTER FROM THE WATER.

Incrusting or Corrosive Substance Held in Solution.	Amount of Reagent. (Pure.)	Foaming Matter Increased.
Sulphuric acid	0.57 lb. lime plus 1.08 lbs. soda ash	1.45 lbs.
Free carbonic acid	1.27 lbs. lime	None.
Calcium carbonate	0.56 lb. lime	None.
Calcium sulphate	0.78 lb. soda ash	1.04 lbs.
Calcium chloride	0.96 lb. soda ash	1.05 lbs.
Calcium nitrate	0.65 lb. soda ash	1.04 lbs.
Magnesium carbonate	1.33 lbs. lime	None.
Magnesium sulphate	0.47 lb. lime plus 0.88 lb. soda ash	1.18 lbs.
Magnesium chloride	0.59 lb. lime plus 1.11 lbs. soda ash	1.22 lbs.
Magnesium nitrate	0.38 lb. lime plus 0.72 lbs. soda ash	1.15 lbs.
Calcium carbonate	1.71 lbs. barium hydrate	None.
Magnesium carbonate	4.05 lbs. barium hydrate	None.
Magnesium sulphate	1.42 lbs. barium hydrate	None.
*Calcium sulphate	1.26 lbs. barium hydrate	None.

*In precipitating the calcium sulphate, there would also be precipitated 0.74-lb. of calcium carbonate or 0.31-lb. of magnesium carbonate, the 1.26 lbs. of barium hydrate performing the work of 0.41-lb. of lime and 0.78-lb. of soda ash, or for reacting on either magnesium or calcium sulphate, 1 lb. of barium hydrate performs the work of 0.33-lbs. of lime plus 0.62-lb. of soda ash, and the lime treatment can be correspondingly reduced.

WATER SOFTENING AT RAILWAY WATER STATIONS.

(Abstract of the Report of the Committee on Water Service).—In order to secure uniform results in treating water and have reaction take place outside of the boiler, thereby relieving it of the accumulation of mud, scale and other damaging materials, the modern mechanical water-softener has been evolved. The mechanical devices for introducing the reagent solutions into the untreated water are various, but the intent is to have the flow of the solutions automatically regulated so as to always be in constant proportion to the flow of water into the softener. This constant proportion is best maintained when this portion of the device is least subject to wear in its parts, providing it is otherwise correctly designed.

Practical experience with the better-designed types of both the continuous and intermittent plants has shown that there is no difference in the efficiency of water-softening, providing the mechanical devices for control of the reagents are properly designed and the correct proportions given to the other parts of the plants. In either type of softener it is essential that sufficient time should elapse between the introduction of the water into the softener and its transfer to the storage tank, to obain proper reaction and precipitation. There are many plants in operation which are a disappointment to the officials, mainly because this important feature has been overlooked, and the actual capacity for a thorough treatment of the water is very much less than the rated capacity.

Practice has demonstrated that between three and four hours is necessary for reaction and precipitation, depending largely on the temperature of the water and the composition of the scaling matter held in solution. Water taken from running streams in winter should have at least four hours' time. In all softeners there should be some form of filter for water to pass through before finally entering the storage tank, in order to eliminate any flakes of scale or mud forming matter that may be held in suspension. At least 3 ft. of the bottom of each settling tank should be reserved for the accumulation of the precipitates; therefore, in estimating the settling space needed and the capacity of settling tanks, the settling space should be considered as lying entirely above this reserved portion.

The above table gives the quantity of reagents needed to remove 1 lb. of incrusting or corroding matter from the water, also the effect on foaming quality of the water. The first portion of the table considers the use of lime and soda ash as reagents, these being the cheapest and the most common in use. The great objection to the use of soda ash is the increase in the foaming tendency of the water. The latter portion of the table gives the quantity of barium hydrate required to treat the carbonates and sulphates of lime and magnesia. The foaming tendency of water is not increased by the barium hydrate treatment, hence its advantage over soda ash as a reagent. Barium hydrate has no advantage over lime as a reagent to precipitate the carbonates of lime and magnesia and should not be considered as a reagent for these substances except in connection with the treating of water containing calcium sulphate.

In treating waters, the acids can be neutralized and the incrusting matter can be reduced to at least [illegible] grains per gallon in most cases. Knowing the analysis of the water and the average quantity used daily, the pounds of matter that can be removed daily at any particular water station can be readily determined, and the quantity and cost of chemicals per day or per annum calculated. The other expenses to be considered are interest on cost of treating plant, depreciation, running repairs, additional labor and fuel or power to operate the plant. The expense for these items will vary, depending on the type of plant used, actual capacity of plant, materials used in construction and the local cost of labor and materials.

In estimating the benefits due to the removal of incrusting solids prior to the introduction of the water into the boilers, it must be remembered that carbonates of lime and magnesia, without the presence of either the sulphates of lime and magnesia, do not form hard scale, but are precipitated in boiler as soft scale and mud, which can be removed for the most part by washing out and blowing off. A very small portion of either of these sulphates, in combination with the carbonates, will cause a hard, troublesome scale and increase the expense of boiler maintenance. With clean boilers, less fuel will be necessary to evaporate a given amount of water. Authorities differ regarding the increased amount of fuel required for a given amount of scale, but a conservative estimate seems to be about 10% increase for each 1-16-in. of scale. The average locomotive with an average steam coal evaporates approximately one gallon of water per sq. ft. of heating surface per hour. The following table shows the number of hours' service required to make 1-16-in. scale for various amounts of incrusting matter:

Incrusting solids per lb., 1,000 gals. water	1	2	3	4	5	6
Hours of service to accumulate 1-16-in. scale	781	391	260	195	156	130

However, the full saving of fuel will not be made if the foaming solids of the water have been increased, as more water will have to be evaporated. To understand this fully we must consider the effects on operating expenses of water containing foaming solids. Where matter is held in suspension in water, priming or foaming begins at an earlier concentration of matter in solution than if no suspended matter be contained in boiler. In actual practice it is found that with a concentration of about 100 grains of foaming solids per gallon in locomotive boilers, trouble from foaming will begin. In order to avoid this trouble, the boilers must be blown off and new water admitted to take the place of this wasted water.

Water containing 10 grains of foaming solids per gallon will have reached the critical concentration on the tenth filling of the boiler; therefore to reduce to the original concentration, the water should be completely changed: that is, 10% of the water taken in the boiler would be blown off and wasted. For 50 grains per gallon of foaming solids, 50% would be wasted, as after one boiler full had been evaporated, the water would have reached the critical point. From this it can be seen that the grains per gallon of foaming solids practically represent the percentage of water that must be wasted by blowing off, as the concentration reaches the critical point. In practice it would probably exceed this, as it would not be policy to blow off large amounts at one time when on the road, on account of the disadvantage of admitting large quantities of cold water to take its place.

LOCOMOTIVE COALING STATIONS.

(From the Report of the Committee on Buildings).—A locomotive coaling plant should minimize the delay to engines while coaling, the delays to coal cars and the cost of handling coal. It is sometimes desired also to accurately measure the coal as delivered to locomotives. At important points, it is sometimes desirable to provide duplicate machinery.

The roundhouse track arrangement should be as compact as possible and at the same time allow the necessary free movement. The question of the proper location of the coaling plant with reference to the cinder pit depends upon the type of plant adopted. In cold weather, delay to the engine after the fire is cleaned is liable to cause leaking, though some of the trouble attributed to this cause is probably due to an unwise use of the injector. Some handle cinders with the machinery for handling coal. This practice is not recommended.

The importance of providing storage room so as to cut down the delay of cars as much as possible is ordinarily underestimated. One day's storage in cars of locomotive coal for the Pennsylvania System costs more than $300,000 a year, figuring that the cars are worth only $1 a day each. An expenditure of $4,000,000 would be justified to avoid holding two days' supply of coal in cars, considering that the structure costs 15% of the original cost for interest, depreciation and maintenance.

Figuring 40 tons to the car, storage in cars costs 2½ cts. per ton per day, and an expense of $61 a ton is justifiable to avoid it. Ordinarily, storage in the bin is much cheaper than in cars, yet the usual practice is to keep from one to five days' supply stored in cars at the different plants. All plants for self-clearing cars should have the hoppers so wide that the coal can be shoveled from flat bottom cars by hand, if desired, and so that side dump cars can be used. Self-clearing cars can be unloaded into a hopper for at least 6 cts. a ton less than the cost of unloading flat bottom cars by hand. Using 15% per annum of the original cost as the cost of the plant, an expense of $146 is justified to save handling one ton a day by hand.

In the statements of cost [see the table at the end of this article.—Ed.] the figures which are not available have been estimated. In order to make a fair comparison, we have assumed that it is desirable to hold at the plant, either in cars or on the ground, a total of three days' supply. The figures are of value in a general way only. We have used 10% of the original cost for interest and depreciation for all plants, independent of the character of construction. Considering the present rate of development, the necessary changes in terminals, etc, this is believed to be none too high. A good many of the plants reported have not been in operation long enough and the length of time over which the costs extend is too short, in most cases, to make the maintenance figures reliable. The lack of uniformity in the collection of the statistics and the varying conditions under which they were prepared, make any close comparisons of little value. They indicate how much a slight variation in the conditions not generally considered can affect the cost. In considering this question, it should be remembered that a saving of dollars per year for the railway, and not cents per ton for the individual plant, is the result to be aimed at.

SHOVELING FROM CARS.—Where the quantity of coal handled is small, and especially at terminal points where the engines lie over night and the coaling can be done by the hostler or watchman, coaling direct from the cars is the cheapest. This work can be helped by elevating the track, on which the coal cars stand, from 2 to 4 ft. above the locomotive track. Shoveling from the coal car direct into the locomotive has the advantage that it delivers the coal in the best possible condition. Crushing, due to handling, is kept at a minimum and large lumps can be broken up ready for the fire by the shoveler. The tendency of large bins to separate the slack from the lumps is avoided.

JIB CRANE.—Where the engines are needed as soon as they can be cared for, where they come bunched or where the hostlers cannot do all the coaling in connection with their other work at the time desired, it is recommended that there be, in addition to the elevated track, an elevated platform with buckets of about one ton capacity into which coal can be shoveled at different times, these buckets to be raised by a jib crane which can be operated by hand or by air from the engine, and to be emptied when the engines come too fast for the men to take care of them. By this method the cost can be kept down to almost that of coaling direct from the cars into the engines. These buckets can be used for emergency coaling stations en route where coal is only occasionally required. By having, instead of buckets, small dump cars on an elevated platform and the coal car track elevated considerably above the track on which the locomotive stands, more engines can be coaled quickly.

THE WILLIAMS-WHITE TYPE.—By still further increasing the elevation, the shoveling can be done directly into bins, by which the amount stored can be increased and a larger number of engines accommodated promptly. These bins can be filled wtih different amounts of coal, so that, by selecting the bin, the amount needed can be obtained. With all of these designs, flat-bottoms are practically necessary.

THE TRESTLE TYPE.—The next step is the construction of the high trestle with the coal car track on top of the storage bins, 30 or 40 ft. above the engine track. The cost of switching is increased, but by the use of self-clearing cars the cost of delivering coal from the cars to the bin can be almost entirely eliminated. The maximum grade for the approach is usually considered as 5%. Where the coal is not shoveled, this type of plant keeps the breakage of the coal at a minimum of all plants where the coal is not shoveled by hand. In considering the expense of operating these plants, the cost of placing the cars on the trestle by a locomotive, an expensive and dangerous operation, is not ordinarily included.

TRESTLE WITH CABLE INCLINE.—Instead of using a locomotive to place the cars, these plants can be equipped with a hoisting engine, allowing the use of a 20% grade. The machinery costs less than the trestle approach, much ground space can be saved, and the operation is cheaper and safer when the cost of switching is considered. This type ordinarily increases the possibilities of providing storage room and does away with a considerable liability to accident.

Where more than two tracks are to be served, and the necessary room is available, the coal car track can be put at right angles to the locomotive tracks. In some cases, where it is desired to coal on four tracks or on two main tracks, duplicate plants are constructed. The trestle types are handicapped by the fact that the structure must sustain heavily loaded cars and also either sustain locomotive engines or have power available to raise the cars. The costs per ton of maintenance are higher than is generally assumed, and if a fireproof structure is built, it would be expensive. They ordinarily cannot be placed in the most desirable location, and are not available in many cases where the room is cramped.

LOCOMOTIVE CRANE TYPE.—At terminals where the demands are not too great, coaling can be done by means of a locomotive crane handling the coal direct from flat-bottom cars to a locomotive. This crane can also help switch coal cars, if necessary, and can handle cinders and sand. To allow the use of drop-bottom cars, a pit can be constructed from which the crane can handle the coal. To avoid delay to locomotives, a trestle can be constructed on which the crane can work, so that it can load direct into bins, in which a fair amount of storage room can be provided. The bins are not protected from the weather, and the coal and the gates are liable to be frozen up. With the necessary tracks, the pit and the hoppers, it will be found that this sort of a plant has a considerable first cost. Its cost of operation depends upon the work which can be provided for the crane at spare times.

Its value is great in emergency situations and at points where, because of impending changes, the construction of a permanent plant is unwise. With a large terminal, where a conveyor plant is used, a locomotive crane would be very valuable to handle cinders and sand and also coal during a possible breakdown of the conveyor. The practical limit of a locomotive crane is said to be about 70 engines a day. The fact that it can unload direct from flat-bottom cars is much in its favor.

CLAM-SHELL BUCKET AND TROLLEY TYPE.—A type of plant using a special bucket of the clam-shell type operated on a trolley has been suggested. This can handle coal direct from a pit or from flat-bottom cars into bins over the tracks, and can also handle cinders. While this device has not yet been tried for coaling locomotives, it is receiving more or less attention and will undoubtedly be tested soon. The number of tracks it can serve is unlimited, and the mechanism is simple. The horse-power required is small and the first cost is not excessive. This type would be especially valuable where self-clearing cars cannot be regularly obtained and where large storage is desired. It is believed that with a plant of tbis type, coal can be handled at a reasonable cost from flat-bottom cars. There should be no difficulty in getting an actual working capacity of 75 tons an hour, which is ordinarily ample.

THE HOLMEN TYPE.—When the space is more or less limited and the amount of coal to be handled and stored is not too great and deep foundations can be constructed, the coal can be lifted into bins by means of two large buckets, operating opposite each other, so that when one is lowered, the other is raised. The coal is delivered into the buckets by gravity from the bottom of a pit under the coal car track through a gate worked by the operator of the bucket. The bucket is automatically dumped into the bins at the top. It requires the continuous attention of a man operating it, but is an efficient machine where the requirements are not too great. The storage room in the bins is limited by the fact that this plant has practically but one point of delivery into the bins.

THE LINK-BELT TYPE.—The bucket conveyor or link-belt type requires a small ground space, has great flexibility of adjustment to suit different conditions, and can be used for almost any situation desired. With the softer grades of bituminous coal, such as that from the Indiana field, these plants tend to break up the coal. Many of these plants are in operation, and, where well cared for, they are giving excellent service. The expense of power and repairs are not great, and, where the conditions are such as to recommend their construction, they give good service at a reasonable cost.

THE ROBBINS BELT TYPE.—Plants raising the coal on a continuous belt of rubber and cotton on an incline of about 30° are coming into use. The maintenance cost is reasonable, and in most situations it can be as readily fitted in as any other type. In some locations, where plenty of space is available, a better storage yard for coal cars can be provided with this than by any other type, as the receiving hopper can be placed a considerable distance from the storage bins in any direction. There are very few parts of this which can get out of order. The expense of belt renewal is only about 0.2 ct. per ton, a comparatively small amount, which makes no appreciable difference in the total cost of maintenance.

GENERAL INFORMATION.—For large plants where coal is delivered in self-clearing cars and an unloading hopper is used, tracks can be so arranged that cars can be handled by gravity, without the need of switch engines, decreasing the cost of operation. A locomotive crane as an auxiliary for handling cinders, sand and coal in emergencies, is very desirable.

Although most roads do not now consider it necessary to weigh the coal accurately as delivered to locomotives, some plants are built with this provision. Storage bins, holding as much as one hundred tons, on scales, are used, or else auxiliary bins on scales, with a capacity of five or ten tons, are placed underneath the large storage bins. The use of scales is sometimes avoided with trestle plants by providing small auxiliary pockets in which the measuring can be done by volume. The scales add considerably to the cost. With belt or bucket conveyors, the bins should be designed so as to prevent an accumulation of slack.

With some grades of coal, where run of mine or lump is used, it is necessary to provide means of breaking it up. Breaker bars can be either placed over the hopper, which will not allow any coal above a certain size to pass without being broken up, or else a crusher can be provided. The breaker bars deliver the coal in better condition, but are more expensive in operation. Where softer grades of coal are used, it is important that the plant be designed to avoid breakage as much as possible.

The handling of sand and cinders is frequently attempted in connection with coaling stations, but unless separate machinery is provided, they have not generally been successfully operated, due largely to the excessive wear caused by the cinders and sand on the moving parts.

Some efficient method of fire protection is very desirable, many expensive plants having been destroyed by fire. The recent and prospective increases in the cost of labor and timber and the demand for greater reliability of service tend to increase the desirability of having better coaling plants built of steel or reinforced concrete.

Conclusions.—(1) The present records of the cost of operation of coaling plants on nearly all roads are incomplete and of little value for comparison wtih each other other.

(2) The cost items should include charges for interest and depreciation, charges for maintenance and operation (the cost of switching cars onto trestles should be included), and a charge for the use of cars for storage purposes.

(3) Plants must be reliable and not cause unnecessary delay to engines or cars.

(4) Provision should be made for fire protection, the avoidance of damage to the coal, and its delivery in the best possible condition.

(5) The use of self-clearing cars should be made possible, and ordinarily it should also be possible to shovel from flat-bottom cars.

(6) Storage for emergency purposes and fireproof construction are, in general, to be recommended, and in some cases duplicate machinery is desirable.

(7) Where self-clearing cars cannot be regularly obtained, either a locomotive crane or a trolley hoist, using a bucket of the clam-shell type, is preferable to loading by hand.

(8) For a small terminal, the two-bucket hoist seems to have good points, where a deep foundation is not too expensive.

(9) For larger plants, some conveyor type is desirable.

The following list of cost of handling coal by the several methods described above is tabulated from the figures given in the report, but the committee expressly states that while these figures are useful in themselves they are of no use for comparison, owing to the lack of uniformity in methods of accounting. The cost in each case includes the following: 1, Interest and depreciation; 2, operation; 3, maintenance, and 4, car storage:

System of Handling.	Tons per day.	Cost per ton. cts. cts.
Shoveling from cars to locomotives	157	17.3
Jib crane and bucket	12	23.2 to 32.0
Shoveling into small dump cars	235	17.8
Shoveling into elevated bin	133	17.5
Dumping into bin (locomotive incline)	305 & 370	9.1 & 12.2
Dumping into bin (cable incline)	166 & 82	9.1 & 14.3
Locomotive crane	195	13.4
Holmen bucket system	113 & 50	8.2 & 15.5
Link-belt conveyor	345 & 450	9.4 & 18.4
Rubber belt conveyor	218 & 127	6.9 & 12.2

* * *

A SEASIDE PARK AT ROCKAWAY BEACH has been approved by the Board of Estimate in New York City. The proposed park comprises some 350 acres, extending from Jamaica Bay on the north to the Atlantic Ocean on the south, the cost of which to the city is estimated at about $1,000,000.

RATING CURRENT METERS THROUGH THE ICE.

By C. ROBERT ADAMS.*

Very recently I had occasion to rate two current meters and took the opportunity to make the ratings through the ice. The experiment proved that this method is both accurate and inexpensive.

I cut a channel through the ice, on a lake, making it 200 ft. long and 1 ft. wide. This channel was cut with ordinary ice saws. At the sides of the channel I had grooves cut to guide the runners of a sled to which my meters were attached. These were chipped out with an ice chisel and were made exactly straight by stretching strings along the sides of the channel. After being left overnight the grooves for the runners had frozen very smooth, and the main channel was quickly opened with an ice chisel. It was then ready for the ratings.

The meters were rated both when attached to a rod and when suspended by a cord. They were fastened to the front of the sled, which was drawn by two men. The number of revolutions were counted by the common method of a make-and-break circuit attached to a buzzer which sounded at each revolution. One man rode on the sled to count the revolutions. Another man on the ice with a stop-watch timed the runs.

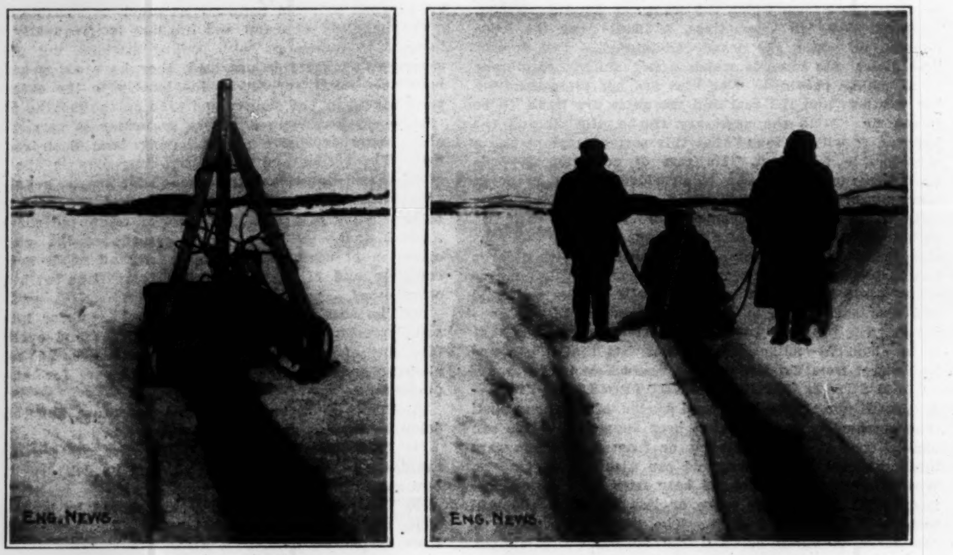

Fig. 1. Sled with Current Meter on Pole. Fig. 2. Ready for Business.

FIGS. 1 AND 2. RATING CURRENT METERS THROUGH THE ICE.

The runs were made at various speeds from a very slow walk to a run. This gave a number of points from which to plot a rating curve for the meter with coordinates of "feet per second" and "revolutions per second." This curve became very nearly a straight line above very low speeds, which is usually the case. If the curve had been exactly a straight line the total number of revolutions in each run would have been a constant, independent of the speed. Deviations from this constant showed at how many speeds to observe, and also indicated that the speed is comparatively a small factor at ordinary velocities. This showed that only at low speeds need we be very careful to move the sled at exactly a uniform rate.

Speeds were taken from ½ to 10 ft. per sec., thus covering all ordinary velocities of running water. These rates were obtained by having the men draw the sled extremely slow at first and increase the speed each trip, until they reached a brisk run.

The meter was kept at a depth of about 8 ft., so as to be free from any influence due to the ice cover of the lake. It was never taken out of the water, for fear of freezing it. The sled was swung around at each end of a run without disturbing the meter. By properly clothing the men they kept perfectly warm, and consequently worked with as much care as would have been possible in warm weather.

Figs. 1 and 2 show the sled with meter attached to a rod, and also the outfit ready to commence a run.

Many engineers are prone to accept rating curves or tables furnished by manufacturers of current meters, or else to make one rating last for years. A meter is very delicate, and its rating is apt to change. Therefore I recommend all engineers who use a current meter to get it out before the ice goes and expend the ten dollars or so necessary to determine its present rating.

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*Care of Union Water Power Co., Lewiston, Me.

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NOTES FROM ENGINEERING SCHOOLS.

HARVARD UNIVERSITY.—Some 670 alumni of the university have donated to the President and Fellows of Harvard College, the sum of $30,500, for the establishment of a "Shaler Memorial Fund," in commemoration of the long services of the late Professor Nathaniel Southgate Shaler and of the great affection in which he was held by his many students and friends.

A portion of the gift is to be used in procuring a memorial tablet, which will be placed in the geological section of the University Museum or other suitable place. The balance of the fund will be invested and the income therefrom used for the support of original research work and the publication of the results of such research in the Division of Geology.

The researches are to be undertaken by persons nominated by a Committee of the Division of Geology and appointed by the University Corporation. Applicants are not to be limited to officers or students of Harvard University. The subject and the locality or field of research, as well as the sums of money allotted for the same, will be determined by the Geological Department's Committee. All work or journeys supported in whole or part by the fund will be carried on under the name "Shaler Memorial Research" or "Shaler Memorial Expedition," while the results of researches, after being approved by the committee, will be published in some established journal under a general title "Shaler Memorial Series." Beneficiaries under the fund must, at the request of the committee, give one or more public lectures in Cambridge on the results of their studies, under the general title "Shaler Memorial Lectures."

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THE ISTHMIAN CANAL COMMISSION REORGANization, it appears from statements given out at Washington, will be completed on April 1. At that time Major Goethals will succeed Mr. Stevens as Chairman of the Commission, and Ex-Senator Joseph C. S. Blackburn, of Kentucky, will succeed to the vacancy on the Commission. It is announced that the salary of Col. Goethals will be $15,000 a year, while Majors Gaillard and Sibert and Admiral Rousseau will receive $14,000 each, and the three other members of the Commission $10,000 each.

FOUR NOTABLE RAILWAY ACCIDENTS have occurred during the past week. The "Chicago Limited" of the Pennsylvania System was ditched 17 miles east of Pittsburg, Pa., March 22, five cars and locomotive leaving the track. No one was killed, but 18 persons were slightly injured. The wreck is said to have been caused by the removal of the bolts and [illegible]-plates joining two rails.

Six students were killed and a score of others injured by a butting collision on the Atchison, Topeka & Santa Fe Ry., at Los Angeles, Cal., March 24. The students were returning from an intercollegiate field meet between the University of Southern California and Occidental College, on a "Special," when it was crashed into by an outbound limited train. The accident is said to have been due to the disobedience of orders by the engineer of the limited train.

The wrecking of the "Southwestern Limited" of the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Avon, Ind., March 22, killed the engine-driver and injured eleven persons, one fatally. The locomotive jumped the track and rolled down a 20-ft. embankment, dragging three coaches with it.

A grade-crossing accident at Detroit, Mich., March 22 injured eleven persons, two fatally. An electric car, in attempting to cross the tracks of the Michigan Central Ry., was struck in the middle by a fast train and demolished. The accident was caused by the conductor of the trolley and the gateman failing to see the approaching train.

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THE WASHOUT OF A BRIDGE of the Chicago, Milwaukee & St. Paul Ry. at Chamberlain, S. Dak., was not a serious affair, as reported in the daily press. It simply consisted of the knocking out by ice of a number of bents of ordinary pile trestle in the approach to the railway company's pontoon bridge. The damage will amount to only a few hundred dollars, and the repairs will be made in a few hours by the company's pile driver and carpenter crews.

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THE EXPLOSION of 1,000 lbs. of dynamite at the plant of the Emporium Powder Co., near Emporium, Pa., March 20, completely demolished the mixing house and killed six laborers employed therein. The property loss is estimated at $7,000.

◆

THE EIGHT-HOUR DAY on government work has been modified by Secretary Taft so that in river and harbor work it will apply only to mechanics and laborers and will not change the present hours of work of captains, cooks, deck-hands, pilots and the like. This latest ruling is a reconsideration of the Secretary's opinion of March 7, 1907, in which he held that the law applied to all of the men engaged in government contract work.

◆

THE PASSAIC VALLEY SEWERAGE BILL has been signed by Governor Stokes. Its provisions were noted in our issue of March 7. Briefly, they prohibit the discharge of untreated sewage into the Passaic River or its tributaries below the city of Paterson after Dec. 12, 1912, and authorize the Passaic Valley Sewerage Commission to enforce the provisions of the act, and, on petition from the municipalities, to construct joint sewage disposal works.

◆

THE PHILADELPHIA FILTRATION SUITS between the City and D. J. McNichol & Co., which have so long been before the public and the courts, are to be submitted to arbitration. The arbitrator chosen, Ex-Judge Samuel G. Thompson, is given absolute deciding power as regards all points at issue, as brought out in the recent lower court trial, and is authorized to take new evidence.

◆

THE PROPOSED BRITISH CHANNEL TUNNEL from England to France is opposed by the British Government. This fact was brought out officially in Parliament not long ago, upon which the leaders of the opposition political party also pronounced themselves against the project. The scheme meets with general political disfavor for both military and sentimental reasons.

◆

THE CITY FREE BRIDGE AT ST. LOUIS, an account of the history of which appeared in Engineering News for March 21, 1907, may be built across the Mississippi River at Chouteau Ave. Two bids for the total construction of bridge and approaches were submitted. Mr. Ralph Modjeski agreed to build the bridge with a main cantilever span of 812 ft. and two side spans, each 406 ft., for $3,016,836, and Waddell & Harrington bid $3,400,000 for the same structure. The Engineer's estimate was $4,520,000. The final plans have not as yet been made nor the contract awarded.

◆

AN AUTOMOBILE HIGHWAY between Boston and New York is proposed and the promoters of the enterprise are now trying to get a charter from the Massachusetts legislature. The highway, as proposed, is to run from a point near the boundary lines of Brookline and Newton, Mass., as nearly in a straight line as possible to Mount

Vernon, N. Y., passing through Massachusetts, Rhode Island, Connecticut, and entering New York State. The entire distance is 170 miles and it is estimated that the cost will be more than $70,000 a mile, or from $12,500,000 to $15,000,000 for the entire roadway. It is proposed to construct two 35-ft. roadways, one for south and one for northbound traffic, with a 30-ft. space outside between the outer edge of the roadways and the fence. The promoters estimate that the tolls from 500 cars a day passing over the highway will make it a paying proposition.

THE U. S. NAVAL COLLIER "Vestal's" keel was laid March [illegible] at the Brooklyn Navy Yard, Brooklyn, N. Y. This vessel, it is said, will be the largest and swiftest collier in the world. She will have a displacement of 12,500 tons, and a speed in excess of 16 knots per hour. Her coal-carrying capacity, exclusive of her own fuel, will be 6,000 tons. Her estimated cost is $1,500,000.

THE FIRST ALL-STEEL MAIL CAR ever built in this country has recently been put into the service on the Pennsylvania R. R., between New York and Washington. The new car, in addition to being a model of fireproof construction, is especially strengthened to resist the hard usage which the mail car's position in the train nearly always brings about in case of accident. It is 75 ft. long, which is 10 ft. longer than the standard wooden cars, 10 ft. wide, and contains only 370 lbs. of wood in its whole make-up. The body framing includes a heavy central box girder, built up of two 18-in. I-beams, with two 24 × ½-in. cover plates and side girders 36 ins. deep. A 12-in. I-beam is placed on each side of each end door, riveted at bottom to steel center sill and casting, and at top a cross beam of channel section. The cross beam distributes the strains, which may come on the vertical I-beams on account of collision, to the roof construction and side plates.

PROGRESS ON THE NEW YORK EXTENSION of the Pennsylvania R. R. is reported to us in an authorized statement of the company, which gives the following facts: A considerable section of the tunneling is actually completed. There has recently been another "meeting" of tunnels—this time in Long Island City. The southernmost of the four approach tunnels being driven from East Ave. under the Long Island Railroad passenger terminal toward the East River has reached the river shaft and is now connected with the tubes that go out under the water. Only three or four days ago the headings bound in opposite directions under 32d St., Manhattan, in the United Engineering & Contracting Co.'s work on the crosstown tunnels, came together nearly under Third Ave., so that there are continuous passages from the East River to Fifth Ave. under both 32d and 33d Sts. The work from Fifth Ave. west to the terminal station site at Seventh Ave. is to be prosecuted by excavation from the surface, on account of grave difficulties confronting the driving of tunnels in this portion.

Under the East River the cast-iron lined tunnels have progressed an aggregate of about 500 yds. per tunnel, counting both east and westbound progress. Those going east from Manhattan, having started a full year earlier, are more advanced. The three to the south, known as B, C and D, are now piercing through the rock of Blackwell's Island reef. The tubes bound from the Long Island City side toward Manhattan are about 350 ft. out under the water. The meeting of the eastbound and westbound tubes will take place considerably to the east of the middle of the river. The work under the East River recently has been more satisfactory in every respect than it was in the earlier stages.

About 85% of the excavation work in the terminal station site, the area bounded by Seventh and Ninth Aves. and 31st and 32d Sts., is done. Between Seventh and Eighth Aves. practically all the excavation is completed. The greater part of the steel work which is to support Eighth Ave. as a bridge over the undergrond tracks is in place. The foundations for the station columns are being laid.

In the connecting line on the New Jersey side, between Harrison, on the present main line of the Pennsylvania, and the Bergen Hill tunnels, several bridges have been constructed. The one over the Hackensack River is nearly finished. Under Bergen Hill itself, through the hard Palisades rock, the tunnelers are making more rapid progress than at any previous time. They are now at work in four sets of headings west from the Weehawken shaft, east from the Hackensack portal on the edge of the Meadows, and east and west from a central shaft, 220 ft. deep.

TYPHOID FEVER AT WASHINGTON during the latter part of 1906 has been reported on at length, but not yet finally, by the U. S. Public Health and Marine-Hospital Service. The report is the result of investigations made by a board of officers appointed by Surgeon-General Wyman, consisting of M. J. Rosenau, Director of the Hygienic Laboratory; L. L. Lumsden, Passed Assistant Surgeon; Joseph H. Kastle, Chief of the Division of Chemistry; and seven passed assistant surgeons. The report is submitted by General Wyman to the Commissioners of the District of Columbia. Of 866 cases of typhoid fever studied by the board, 85, or 10% were attributed to infected milk, the cases falling into three groups. The report shows that the milk supply of the District is very far from being properly supervised. The public ice supply and public wells did not appear to be directly responsible for typhoid infection, but 31 out of 63 shallow wells showed indications of sewage pollution. Personal contact or secondary infection accounts for 54 cases, or 6% of the number investigated, and outside infection for 129 cases, or 15%. This leaves 69% of the cases unaccounted for. About 97.6% of the cases investigated used unboiled Potomac water. The report states that the typhoid bacillus has never been isolated from the Potomac River water and that there is "no direct evidence to prove or disprove the assertion that some of the infection may or may not be waterborne." While the water supply is thus left somewhat in doubt the report is conservative on this general subject, recognizing the value of filtration at Washington and elsewhere, and stating that further investigations of water supply questions will be made.

THE EXTENSION OF THE CHICAGO DRAINAGE Canal to Joliet is projected, and the Sanitary Trustees have the cooperation of the Illinois & Michigan Canal Commission in this proposed 3½-mile extension. It is stated that the project will be strongly opposed by the Economy Light & Power Co., which derives its water power from a dam which will be removed from the canal. The present retaining wall to prevent damage by floods north of Joliet, will be extended to a new dam 2½ miles below the present dam. This new dam will raise the water in the Des Plaines River to a navigable depth, and will enable water power to be utilized to develop about 40,000 HP.; this is in addition to the 35,000 HP. developed at Lockport, and both would be used to generate electric current for use in lighting the streets of Chicago. It is suggested that the extension may be another link in the projected deep waterway to St. Louis. The plans and the necessary legislative bills for the new work will be prepared under the direction of a commission composed as follows: Mr. Isham Randolph, Chief Engineer of the Drainage Canal; Mr. L. E. Cooley, Consulting Engineer; Mr. R. R. McCormick, President of the Drainage Canal; Mr. G. S. Snively, President of the Illinois & Michigan Canal Commission, and Mr. L. McDonald, Superintendent of the Illinois & Michigan Canal.

A TRADE SCHOOL, to be known as the Franklin Union, is to be built at Berkeley and Appleton Sts., Boston, Mass. The building will be erected and maintained by the fund left to the city of Boston by Benjamin Franklin, which matured and became available for use a year ago and which has been doubled by an endowment from Andrew Carnegie. The proposed building will be four stories high and will be built of brick and stone. The basement will contain a model boiler room, a steam and hydraulic laboratory, an electrical laboratory, an automobile laboratory and a clay-modeling room. The upper floors will be devoted to exhibition purposes, executive offices, chemical and physical laboratories, and class and recitation rooms. A library and large lecture hall will also be provided.

It is expected that the school will be used mainly for evening work, thus affording an opportunity for young men employed during the day to obtain a better education along what ever line they desire. Students will be instructed in the proper care and operation of machines, besides pursuing studies that will better fit them for their work.

THE STRUCTURAL MATERIALS TESTING of the U. S. Geological Survey is supported by an appropriation of $100,000 made by Congress at its recent session after this item had been cut out of the Sundry Civil Bill in committee. This appropriation assures the continuance of the work at St. Louis until June 30, 1908.

THE UNITED STATES NAVY has under construction nine battleships, four armored cruisers, one protected cruiser, three scout cruisers and four submarine torpedo boats. Wm. Cramp & Sons has contract for building three of the battleships; the New York Shipbuilding Co. has contracts for three battleships; the Newport News Shipbuilding & Drydock Co. has contracts for one battleship and two armored cruisers; the Fore River Shipbuilding Co. has contracts for one battleship, two scout cruisers, and four submarine torpedo boats; Morgan Bros. haye a contract for one battleship; the Union Iron Works has contracts for two armored cruisers and one protected cruiser; the Bath Iron Works has a contract for one scout cruiser. The contract work on the battleships "Vermont" and "Minnesota" has lately been completed and the vessels delivered to the Government. The "Nebraska" and "Kansas" are practically completed, while the "Mississippi," "Idaho" and "New Hampshire" are about three-fourths completed. The "South Carolina" and "Michigan" are only about one-tenth completed. The contract work on the armored cruisers "California" and "South Dakota" is very nearly completed, while the "North Carolina" and "Montana" are about three-fourths completed. The protected cruiser "Milwaukee" is completed as far as the contract work is concerned. The three scout cruisers, the "Chester," "Birmingham" and "Salem," are about three-fourths completed, while the four submarine boats, Nos. 9, 10, 11 and 12, are nearly completed. The speed of the different battleships runs from 17 to 19 knots per hour, while all of the cruisers will have a speed of 22 knots per hour.

VERY LARGE ELEVATED WATER TANKS are to be built by the city of Hamburg, Germany. One tower, 82 ft. in diameter, will contain two cylindrical tanks, one above the other, of 525,000 gals. and 660,000 gals. capacity each; the water surface of the upper tank is to be 138 ft. above ground. Another tower, 61 ft. in diameter, will contain a tank of 400,000 gals. capacity, with water surface 161 ft. above ground. The third tower of the series, 75 ft. in diameter, will contain a tank of 525,000 gals., with water level 98 ft. above ground. The towers are to be of brick masonry. In order to secure a maximum of aesthetic effect, the city arranged an open competition for architectural sketches, from which the designs were selected.

DUMPING GARBAGE IN THE CANALS of New York State has been prohibited by Mr. Frederick C. Stevens, Superintendent of Public Works.

A TROLLEY LINE ON THE FELLSWAY BOULEvard, from Broadway Park, Somerville, Mass., to Spot Pond in the heart of the Middlesex Fells, will make available that 3,000-acre reservation of the Metropolitan Park Commission (Boston). The line will be double-tracked, will be about 4½ miles in length, and will be built by the Boston Elevated Co. Its termination at Spot Pond will be near the Winchester reservoirs and the Bear Hill observatory.

A MECHANICAL FILTRATION PLANT for Grand Rapids, Mich., has been recommended by L. W. Anderson, City Engineer. The question of an improved water supply for Grand Rapids has been a troublesome one for many years, and gave rise several years ago to extensive bribery scandals. Reports on various projects have been made by a number of different engineers. The average daily water consumption of the entire city is now some 12,000,000 or 13,000,000 gals.

PERSONALS.

Mr. R. B. Fowler has been promoted from Superintendent to General Manager of the New Orleans Terminal Co.

Mr. W. A. Whitney has been appointed General Superintendent of the Rio Grande Western Ry., to succeed Mr. George Geiger, resigned.

Mr. W. F. Jones, General Traffic Manager of the Denver, Northwestern & Pacific Ry., has been elected President of the Chesapeake Beach Ry.

Mr. W. L. Garland has been appointed General Agent of the Safety Car Heating & Lighting Co., at Philadelphia, Pa., to succeed Mr. B. V. H. Johnson, resigned.

Mr. H. J. Roth has been appointed Assistant Superintendent of the Rio Grande Western Ry.'s division between Ogden and Helper, Utah, to succeed Mr. N. H. Holden.

Mr. J. B. Paul has been elected Vice-President of the New Orleans Pacific Ry., which is the Louisiana Division of the Texas & Pacific System. He succeeds the late Robert Strong.

Mr. E. M. McIlvain, formerly President of the Bethlehem Steel Co., has been elected President and General Manager of the Robins Conveying Belt Co., Park Row Building, New York City.

Mr. Magnus Hellstrom, Assistant Engineer to H. de B. Parsons, Consulting Engineer, New York City, has become General Superintendent for A. Hansson, General Contractor, Stockholm, Sweden.

Mr. Frederick A. Waldron has resigned as Engineer of Works for the National Cash Register Co., of Dayton, Ohio, and contemplates opening an office in New York City as a Consulting and Constructing Engineer.

Mr. Agustas Radtzki, Superintendent of the Victoria Division of the Southern Pacific, has been promoted to be General Superintendent of the Houston & Texas Central R. R. and the Houston, East & West Texas Ry., to succeed Mr. Geo. F. Hawks, resigned.

Mr. J. N. Seale as been appointed Manager of the Northern and Eastern Districts of the Southern Ry., with headquarters at Washington, D. C., while Mr. M. M. Richey is made Manager of the Middle and Western Districts, with headquarters at Atlanta, Ga.

Mr. F. A. Molitor, M. Am. Soc. C. E., has resigned as Supervising Railway Expert to the Philippine Government. He will leave Manila, P. I., April 1, and, after examining the railway systems in operation or under construction in the Far East, return to the United States in the fall. His address, after leaving Manila will be care of the University Club, 1015 Walnut St., Philadelphia, Pa.

Obituary.

William L. Guillaudeu, President of the Old Dominion Steamship Co., died at his home in New York City March 24, of apoplexy, aged 54 years. He had been connected with the steamship company for 37 years.

Benjamin F. Davenport, formerly an engineer in the Chicago Sewer Department, died in Nebraska March 18, at the age of 60. He was one of the engineers engaged in installing the sewer system of Havana, Cuba, after the Spanish-American War.

Gen. Joseph F. Boyd, for 30 years Superintendent of the Cumberland Valley R. R., died at Chambersburg, Pa., March 23, of paralysis, aged 74 years. He was a native of Ohio, and served through the Civil War. Before the war he was employed by the Bellefontaine & Indiana R. R., and later by the Louisville & Nashville R. R. In 1866 he resigned from the army and reenlisted the employ of the Louisville & Nashville R. R. He was made Superintendent of the Cumberland Valley R. R. in 1873, which position he held until 1903, when he became the company's Purchasing Agent.

William Millar Deutsch, one of the pioneers in the introduction of mechanical water filters, died suddenly at the Fifth Avenue Hotel, New York City, on March 22. Mr. Deutsch was prominently connected with several filtration companies, in succession, and was engaged in the protracted litigation over the validity of the Hyatt patents. For some years past he was the proprietor of the so-called Federal filtration system. At the time of his death he had offices at 141 Broadway, New York City.

ENGINEERING SOCIETIES.

COMING MEETINGS.

IOWA ELECTRICAL ASSOCIATION.
April 18-19. Annual Meeting at Clinton, Iowa. Secy., L. P. Spinney, Iowa State College, Ames, Iowa.
THE AMERICAN RAILWAY ASSOCIATION.
April 24. Annual Meeting at Chicago. Secy., W. F. Allen, 24 Park Pl., New York City.
AMERICAN ELECTROCHEMICAL SOCIETY.
May 2-4. Annual meeting at Philadelphia, Pa. Secy., S. S. Sadtler, 39 South 10th St., Philadelphia, Pa.
AMERICAN FOUNDRYMEN'S ASSOCIATION.
May 21-24. Annual convention at Philadelphia, Pa. Secy., Richard Moldenke, Watchung, N. J.
NATIONAL FIRE PROTECTION ASSOCIATION.
May 22-24. Annual Meeting at New York City. Secy., W. H. Merrill, 382 Ohio St., Chicago, Ill.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 28-31. Semi-annual Meeting at Indianapolis, Ind. Secy., Mr. Calvin W. Rice, Engineering Societies Bldg., 33 West 39th St., New York City.

ASSOCIATION OF AMERICAN CEMENT MANUFACTURERS.—The quarterly meeting will be held at the Bellevue-Stratford Hotel, Philadelphia, Pa., April 9-10. Mr. George S. Webster, M. Am. Soc. C. E., will read a paper on "Concrete Bridges"; Mr. Walter S. Hassam a paper on "Cement Concrete Roads", and Mr. H. L. Weber a paper on "Concrete Street Pavements."

MEMPHIS ENGINEERING SOCIETY.—At a meeting held March 12 the society adopted resolutions favoring a deep waterway through the Mississippi Valley, by the way of the Illinois and Mississippi rivers. A committee was appointed to collect data bearing on the cost, feasibility and benefits of such a waterway, special attention to be paid to that section of the Mississippi Valley lying between Cairo, Ill., and Vicksburg, Miss. The society will also endeavor to obtain the cooperation of other organizations of the city in forwarding the agitation.

AMERICAN FOUNDRYMEN'S ASSOCIATION.—The annual convention will be held at Philadelphia, Pa., May 21 to 24. The Bellevue-Stratford Hotel will be the headquarters of the association during the convention. The sessions of the association will be held in the Second Regiment Armory, and here also will be displayed the exhibits. There will also be an outdoor melting annex. All the sessions and exhibits will be open to visitors, but the entertainments will be limited to members and invited guests. The social features will include a river trip and a shad dinner.

CANADIAN MINING INSTITUTE.—The annual meeting was held at the King Edward Hotel, Toronto, March 6 to 8. The bill before the Ontario Legislature, providing for the taxation of mines, was fully discussed and declared to be not only opposed to the mining interests but also to the manufacturing and agricultural interests of the province. A committee was appointed and visited the Hon. Frank Cochrane, Minister of Mines, who proposed the bill, laying before him the objections of the institute. The result of the interview was that Mr. Cochrane agreed to support a new bill, drafted to meet the views of the institute, provided it was submitted to him within one year. This the committee agreed to do. Some forty papers, largely on subjects of local interest, were read during the meeting. The election of officers resulted as follows: President, Mr. Frederick Keffer, Green Wood, B. C.; Vice-Presidents, Dr. J. Bonsall Porter, Montreal; Prof. W. G. Miller, Toronto, and Mr. W. Fleet Robertson, Victoria, B. C.; Secretary, Mr. Mortimer Lamb, Montreal; Treasurer, Mr. J. Stevenson Brown, Montreal; Councillors, Messrs. E. W. Gilman, James McAvoy, Frank B. Smith, R. W. Brock, J. C. Gwillian, F. D. Adams, H. E. T. Haultain and D. H. Brown.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS—The regular monthly meeting was held in the Auditorium of the Engineering Societies Building, 33 West 39th St., New York City, March 21. This was ladies' night, and the large hall was filled to overflowing, there being something over 1,000 persons present. In place of a technical paper, Mr. John W. Lieb, Jr., Vice-President of the society, gave a lecture on "Vesuvius and Pompeii", in which, after outlining the composition and formation of volcanos, he gave the history of Vesuvius and its outbreaks from earliest times. The destruction of Pompeii and Herculaneum was also described, together with the state of the mechanic arts of those cities at the time of their destruction.

The lecture was fully illustrated by lantern slides showing views of Vesuvius, the National Observatory, the incline cable road which runs nearly to the crater, on a gradient of from 60 to 80%, etc., besides views of the excavated cities and recovered household articles, surgical instruments, jewelry and statuary. Following Mr. Lieb's address, Mr. A. Burton Holmes, who was at Naples during the last eruption of Vesuvius, showed moving pictures of the volcano in action, flowing lava beds, etc.

Before adjourning, President Frederick R. Hutton brought forth great applause by announcing that he held in his hand a check for $50,000, made payable to the American Institute of Electrical Engineers, it being the donation of the Westinghouse Electric & Manufacturing Co. towards the $350,000 mortgage on the new home of the societies.

WESTERN SOCIETY OF ENGINEERS.—At the meeting held at the society's rooms in the Monadnock Block, Chicago, on March 20, a paper on "The U. S. Geological Survey Fuel Tests Under Steam Boilers" was presented by Prof. L. P. Breckenridge, of the University of Illinois. The testing plant was installed at the St. Louis Exhibition in 1904, and maintained in service after the close of the exhibition. Its operations have been subdivided as follows: (1) Field work; (2) Chemical investigations; (3) Steaming tests; (4) Gas producer tests; (5) Coking tests; (6) Briquetting tests; (7) Washing tests. A national advisory board of 30 prominent engineers and others has been appointed by the President, and to this board the plans of the several subdivisions are submitted from time to time for discussion, criticism and approval. The plant is now being dismantled and moved to the Jamestown Exhibition, but it is supposed that a permanent location will soon be chosen, and that suitable laboratories and quarters will be provided.

In regard to the steaming tests it is difficult to say how far comparisons are justified, as many of the coals would doubtless have given better results in another type of furnace. More than 500 of these tests have been made on coals from all parts of the country, and Prof. Breckenridge illustrated the results obtained by a number of charts and diagrams. Tests of the boiler efficiency and the rate of heat transmission have also been made. Special investigations were made as to the circulation of water through the water tubes of the Heine boiler at the plant, and as to the heat transmission through the tubes of a small multitubular boiler.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS held its regular meeting at its house on March 20, 1907. Prof. Mansfield Merriman occupied the chair. The paper of the evening, read by the Assistant Secretary, was "The Lower Colorado River and the Salton Basin," by Mr. C. E. Grunsky. The paper described in detail the work that has been carried on for the last few years to return the Colorado River to its natural course into the Gulf of California instead of its lately developed tendency to flow inland to the Salton Basin. The paper called forth some discussion, especially by engineers who have been engaged on similar work on Mississippi levees. Mr. W. G. Price suggested that the closure might be effected by a series of mattresses, one on top the other, with no underlying pile foundation, but so constructed that the water pressure constantly forces them downward into the soft silt bottom. Mr. T. G. Dabney wrote that the cause of the last failure in the closure work was probably due to the absence of a so-called "muck ditch," or core wall foundation under the clay dam, and to the construction of borrow pits on the Canal side so near the river, thus giving but a small strip of earth to act as a retaining wall. Mr. W. de H. Washington, who has just returned from the scene of this great work, gave a very interesting description of the conditions on the ground at the present time, and also exhibited many photographs of the surrounding country. He said that the main cause of the difficulty of the work lay in the absolute [illegible]lessness of the soil as a bearing agent. This soil [illegible]sts entirely of an impalpable alkali silt, showing [illegible] signs of grit or sand, and, under the action of water [illegible]oming a fluid muck. Piles varying from 65 to 100 [illegible] length are pushed out of the ground like "corks o[illegible] a champagne bottle" under the uplighting action of [illegible]flowing water. The final closure was effected by [illegible]g three parallel trestles across the opening and dump[illegible] between them loads of 5 and 6 ton rock in batches of [illegible]r loads. This rock was then filled first with grave[illegible]n with clay, and finally the river silk was pump[illegible] over the entire structure.

An announcement was made of the probable arrangements of this coming summer convention of the society at the City of Mexico. These plans are subject to minor alterations, but in the main will hold. The convention will begin Monday, July 8, 1907. A railway rate of one fare for the round trip is expected, and a special train will be made up from the U. S. boundaries. It is expected that a period of three weeks will be needed for the regular meetings, including time of travel to and from the remotest part of this country. This does not include side trips to the Isthmus of Tehuantepec or the Necaxa Power Plant. Contrary to the general impression, the members are assured that the climate of Mexico in July is delightful, and much more pleasant than in most parts of the United States. A circular describing the trip authoritatively and in detail will be sent soon to each member.

RAILWAY SIGNAL ASSOCIATION.—A meeting of this association was held at the Great Northern Hotel, on March 18, with about 60 members in attendance. The first subject was the discussion of certain parts of the general specifications for electric interlocking plants, as prepared by a committee and already printed in the Proceedings for 1906. The proper construction of trunking for enclosing the wires was discussed, and Mr. Rudd explained that on the Pennsylvania Lines it is made practically level with the top of the ballast and covered with a thin layer of ballast. It is thus concealed and protected, but is easily accessible. On the Pennsylvania Lines and the Lake Shore & Michigan Southern Ry. the wires in the trunking are coated with pitch, the material having a low melting point (about 150°) so as to avoid injury to the insulation. This treatment adds greatly to the life of the wire. A paper on "The Installation and Maintenance of Storage Batteries" was read by Mr. H. M. Beck (Electric Storage Battery Co.), and led to considerable discussion as to methods of testing the batteries used in signal plants.

A discussion on Signal Lamps was taken up at the afternoon session, and related very largely to the desirability of having certain standard dimensions to ensure uniformity. At the present time the makers have various designs, and several railways have their own designs, so that when a manufacturer takes a contract it may be necessary for him to have drawings and sample lamps to work from. One specially important point is to have a uniform height from the lamp bracket to the center of the lens, so that all lamps will register properly with the openings in the signal arm casting. Mr. Peabody (C. & N. W. Ry.) thought the committee should discuss the matter with lamp manufacturers and see if standard dimensions are practicable. He has had trouble with the crusting of wicks in long-time burners, especially in cold and windy weather, and has made an improvement by reducing the down-draft area to one-sixth of that originally provided. The Pennsylvania Lines have also had trouble due to crusted wicks, and consider it doubtful whether the down-draft lamp is the best, although strongly recommended by the committee.

Some sections of the report of the special committee on Interlocking and Block Signals were then taken up for discussion, and in this connection Mr. Rudd described an experimental system of signaling now in use on the Pennsylvania R. R. Each post has three arms and lights, giving a variety of combinations to cover high, medium and low speed routes; the semaphore arms move in the upper right-hand quadrant, moving upwards from the horizontal ("clear") to the inclined ("caution") and vertical ("stop") positions. One paragraph in the specifications provided that automatic home block signals should have a single arm with its end pointed; this was voted down. The following paragraphs were approved, but this is an informal action, and no definite action will be taken until the annual meeting:

The "stop" indication shall be given by red lights in a vertical line.

The "stop and then proceed" indication shall be given by red lights in an oblique line.

Lights in a horizontal line shall be used for information signals.

Interlocking home signals shall always have two full-sized arms representing unlimited and limited or medium speeds; and shall also have one low-speed arm, distinguished by a greater interval between it and the second arm than that between the top and second arms, and by a dim light at night, when such low-speed arm is required. The arms to have square ends.

The stop indication of dwarf signals shall be given by a purple light.

The home signal shall be displayed in the 45° position to indicate that the advance signal is at "stop."

Interlocking distant signals shall be provided with two arms.